AQUARIUS/SAC-D

Project Implementation Plan

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Project Implementation Plan

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Preface

Mission Description

The Aquarius/ Satélite de Aplicaciones Científicas, flight D (SAC-D) mission is a partnership between National Aeronautics and Space Administration (NASA) and Comisión Nacional de Actividades Espaciales (CONAE), the Argentine space agency, to plan, develop, collect and return science data from an Earth-orbiting system.

The Aquarius (AQ) Project is a part of the Earth System Science Pathfinder (ESSP) Program in the NASA Science Mission Directorate (SMD) which will deliver sea surface salinity (SSS) data products. The project will deliver an instrument and ground system for Aquarius science data processing. The ESSP program will provide the launch vehicle and associated launch services for the Aquarius/SAC-D mission.

The SAC-D Project is a CONAE remote sensing mission that will measure geological and atmospheric parameters and demonstrates CONAE-unique technology in orbit. In addition, SAC-D will provide the spacecraft bus, henceforth referred to as the Service Platform (S/P); integrate, deliver, and test the Observatory which is the integrated S/P, Aquarius, and SAC-D instrument suite; and contribute mission operations control and the primary ground station.

Purpose

The Aquarius/SAC-D Project Implementation Plan (PIP) is an agreement among the Aquarius and SAC-D Project Managers, Aquarius and SAC-D Principal Investigators, the JPL Director for Earth Science Technology, and the CONAE Manager of Projects for how the Aquarius/SAC-D mission will be implemented throughout the projects lifecycle. This document is jointly written as required in the NASA-CONAE Memorandum of Understanding (MOU), signed 2 March 2004.

The PIP provides the detailed plans for how the mission commitments will be achieved. This plan covers all aspects of a project's implementation as described in the Jet Propulsion Laboratory (JPL) *Flight Project Practices* (FPP), *revision 5*.

The PIP is a virtual document when read on a computer screen, and it is embedded with URLs for various standalone plans, governing documents, and agreements. A complete listing of all Aquarius and Aquarius/SAC-D controlled documents is maintained in the JPL Product Data Management Systems (PDMS) Aquarius Library and links to these documents can be found on the Aquarius Project Information Center (APIC) website. All SAC-D controlled documents reside in the SAC-D Project Information Center (SPIC) library.

Reference Documents

The PIP will be updated as required and approved during a project's lifecycle if there are major changes in project scope. Following initial release, revisions to this document will be recorded in the Document Change Log and will be handled in accordance with the procedures specified in the *Aquarius Information, IT and Configuration Management Plan (AQ-213-0085)*.

Every effort has been made to ensure the PIP is consistent with the requirements and processes defined in the governing documents. In the event of a discrepancy, the documents listed below shall take precedence:

Document Number	Document Title
AS-131-0023	*NASA-CONAE Memorandum of Understanding*
AQ-111-0010	*Aquarius Task Plan Implementation Phase*
AQ-121-0021	*Level 1 Aquarius Mission Requirements*
SD-121-0063	*Level 1 SAC-D Mission Requirements*
AQ-111-0012	*Aquarius Project Plan*
AQ-211-0065	*Technical Assistance Agreement*

Table 1 Governing Documents

The following documents are referenced and provide requirements and guidelines to overall Aquarius implementation practices:

Document Number	Document Title
NPG 7120.5B & NPG 7120.5C	*NASA Program & Project Management Processes & Requirements*
DocID 43913 JPL D-17868	*Design, Verification/Validation and Operations Principles for Flight Systems, Rev. 2*
DocID 58032	*Flight Project Practices, Rev. 5*
DocID 57653 JPL D-23713	Software Development Requirements, Rev. 5

Table 2 JPL / NASA Documents

The documents contained in the Aquarius/SAC-D Project Document List (PDL) and referenced in this document represent the relevant pre-launch data, including mission requirements, design, constraints, analyses, safety, and operations information and any such additional equipment and documentation as may be required by the Aquarius and SAC-D projects. The following documents are associated with the PIP and may expand upon processes and interfaces defined herein:

Document Number	Document Title
AQ-222-0039	Level 2A Aquarius Science Requirements
SD-222-0064	Level 2A SAC-D Science Requirements
AS-223-0101	Level 2B Aquarius/SAC-D Mission System Requirements
AS-2210-0005	Level 2B Aquarius/SAC-D Environmental Requirements
AS-2210-0002	Level 2B AQ/SAC-D Safety & Product Assurance Reqmts
AS-2210-0002	Aquarius Export Control Plan
AQ-211-0260	Aquarius/SAC-D Crisis Response Plan
AS-211-0166	Aquarius/SAC-D Mission Review Plan
AQ-211-0126	Aquarius Acquisition Plan
SD-214-0042	SAC-D Acquisition Plan
AQ-212-0189	Aquarius Science Management Plan
SD-212-0083	SAC-D Science Management Plan
SD-212-5000	SAC-D Descope Plan
AQ-218-0127	Aquarius Education and Public Outreach Plan
SD-218-0047	SAC-D CONAE Education and Public Outreach Plan
AQ-213-0093	Aquarius/SAC-D System Engineering Implementation Plan
AS-213-0091	Aquarius/SAC-D Risk Management Plan
AS-213-0089	Aquarius/SAC-D Technical Resource and Margin Plan
AQ-215-0106	Aquarius Contamination Control Plan
SD-314-0049	SD Observatory Contamination Control Plan
AQ-315-0193	Aquarius Materials and Processes Control Plan
SD-314-0053	SD Materials and Processes Control Plan
AS-213-0097	Aquarius/SAC-D Mission Plan
AS-213-0196	Aquarius/SAC-D Mission Verification and Validation Plan
AQ-213-0098	Aquarius Verification and Validation Plan
AQ-213-0085	Aquarius Information, IT and Configuration Management Plan
SD-213-0045	SAC-D Information Management Plan
SD-213-0222	SAC-D Configuration Management Plan
AS-314-0015	Aquarius/SAC-D Cooperative Monitoring Plan
AS-211-0248	Aquarius/SAC-D Launch Service Implementation Plan
AS-2110-0004	Aquarius/SAC-D System Safety Plan
AS-2110-0001	Aquarius/SAC-D Mission Assurance Plan
AQ-2110-0130	Aquarius Mission Assurance Plan
SD-2110-0132	SAC-D Mission Assurance Plan
AQ-2110-0133	Aquarius Mission Operation Assurance Plan
SD-2110-0194	SAC-D Mission Operations Assurance Plan

Table 3 Associated Documents

1 Project Management Implementation Planning

The Aquarius/SAC-D Mission will be managed in accordance with the NASA-CONAE MOU, dated 2 March 2004. CONAE is responsible for ensuring the overall success of the Aquarius/SAC-D mission. JPL is the lead implementing center throughout the Implementation Phase for the Aquarius project. This responsibility is transferred to Goddard Space Flight Center (GSFC) during the Operations Phase. The partner roles and responsibilities are shown in Figure 1.1-1 and the roles and responsibilities among the three primary implementing institutions as described in Table 1.1-1. The Aquarius/SAC-D Phase E Organization is shown in Figure 1.11-1.

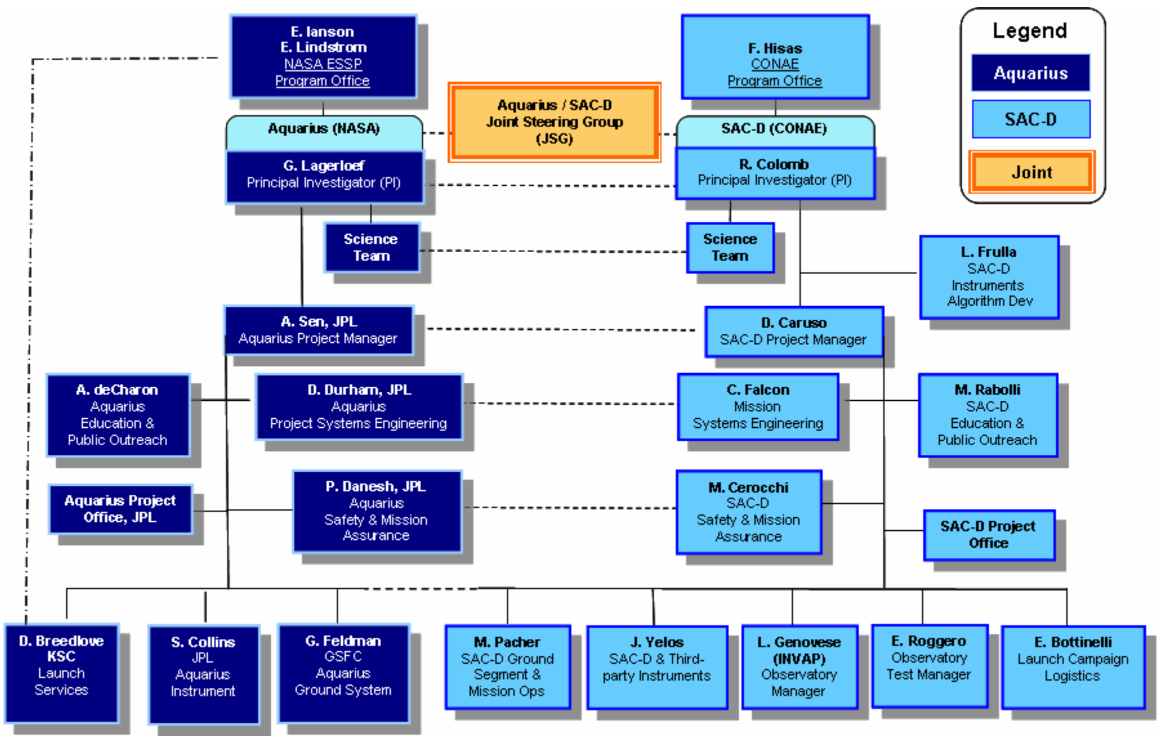

Figure 1.1-1 Aquarius/SAC-D Phase C/D Organizations

Institution	Responsibilities	Roles
JPL	1) Lead NASA center responsible for overall Aquarius Project management during development 2) Lead and coordinate Aquarius System Engineering effort 3) Lead coordinated Aquarius Safety and Mission Assurance efforts 4) Responsible for design, build, integrate and test the Aquarius Instrument 5) Provide LV interface compatibility	• Aquarius Project Manager (PM) • Aquarius Project System Engineer (PSE) • Aquarius Instrument Manager (IM) • Aquarius Mission Assurance Manager (MAM) • Aquarius Project Scientist • Launch Vehicle (LV) Interface System Engineer
GSFC	1) Manage the radiometer, Aquarius science and the associated contracts, and Aquarius ground system development 2) Lead NASA center responsible for overall Aquarius Project management, mission assurance, and system engineering during operations 3) Develop, test and deliver to JPL the Aquarius radiometers 4) Aquarius Ground System design, development and implementation 5) Lead Aquarius science algorithm, calibration and validation	• Aquarius Principal Investigator, Aquarius Deputy PI and science management • PM during operations • Aquarius Ground System Manager • Aquarius Operations Assurance Manager
CONAE	1) Responsible for overall SAC-D project management, SAC-D science, and mission systems engineering effort 2) Design, build, integrate and test the SAC-D Service Platform 3) Observatory-level integration and testing 4) Develop and/or deliver the CONAE instruments 5) Provide support for launch vehicle interface development and Observatory launch site operations support 6) Establish and conduct the SAC-D Safety and Mission Assurance program 7) Develop and operate the SAC-D Ground System	• SAC-D Project Manager • SAC-D Mission Assurance Manager • Mission Systems Engineer (MSE) • Observatory Systems Engineer • SAC-D Payload Engineer • SAC-D Ground System Manager

Table 1.1-1 Aquarius/SAC-D Mission Partner Roles and Responsibilities

1.1 *Key Project Personnel*

1.1.1 Key Aquarius Project Personnel

The NASA SMD has been assigned programmatic, scientific and technical authority for the ESSP program. The Governing Program Management Council (GPMC) is the NASA SMD Program Management Council (PMC). Aquarius is a Principal Investigator (PI)-led project within the ESSP program. Project implementation authority is delegated from the Aquarius PI to the Director of JPL. The JPL Director has delegated the implementation authority to the Earth Science and Technology Directorate (ESTD) and Aquarius Project Manager. The JPL GPMC shall have oversight responsibility for the Aquarius Mission.

The Aquarius PI leads the Aquarius science investigation and is responsible to NASA for the scientific integrity of the mission and achieving mission success. The Aquarius PI also organizes and leads the Aquarius Science Team including algorithm development. The Deputy PI is responsible for managing the Science Team in the PI's absence. The Aquarius PI delegates day-to-day project implementation authority to the Aquarius Project Manager (PM).

The Aquarius PM will oversee and have authority over the day-to-day management of the project, including project systems engineering, Safety and Mission Assurance (SMA), and instrument development. The PM represents the PI in all implementation aspects of the mission. The PM maintains oversight of project activities, ensures timely detection and correction of problems and risks, and analyzes and assesses cost and work progress against plans and schedule. The PM is responsible to the PI for overall cost, schedule and technical performance and for risk management. He is responsible for managing project resources, including all budget and schedule reserves, and successfully implementing the project. The Aquarius PM is the primary point of contact with the SAC-D PM during Phases B/C/D.

A NASA/CONAE Joint Steering Group (JSG) shall govern the U.S. and Argentine contributions to the Aquarius/SAC-D Mission (as defined in the NASA-CONAE MOU). The JSG provides overall guidance to the Project and decides any matters that affect the mission launch schedule, Level 1 Mission Requirements, or other implementation issues not resolved by the respective PM. Membership of the JSG is as follows:

CONAE

- Executive and Technical Director
- Program Manager
- Principal Investigator
- Project Manager

NASA

- Science Mission Directorate representative
- Program Executive
- Program Scientist
- Principal Investigator

- Project Manager
- JPL Center Director (or designee)
- GSFC Center Director (or designee)

The JSG is co-chaired by the NASA Aquarius and CONAE SAC-D Principal Investigators (PIs). The initial JSG meeting shall precede the Aquarius/SAC-D Preliminary Design Review (PDR). The JSG may also meet prior to other major project reviews, at key milestones, or as required.

The Aquarius PSE leads the Project Systems Engineering Team (PSET) that includes representation from each major Project element and the Mission System Engineering Team (MSET). Working with the MSET, the Aquarius PSE develops Level-2 Mission Requirements, the interface requirements, and the verification requirements and controls. The Aquarius PSE conducts trade studies and manages Aquarius technical resources. The Aquarius PSE prepares documentation that communicates and coordinates the activities of system developers.

The Aquarius Mission Assurance Manager (MAM) has primary responsibility for Aquarius SMA. The MAM manages project safety, reliability, quality assurance, and parts. The Aquarius MAM oversees the mission assurance activities at all contractor and partner facilities to assure full compliance to the Aquarius mission requirements. The MAM coordinates mission assurance efforts with his counterpart on the SAC-D team.

The Aquarius Instrument Manager (IM) is responsible for managing the design, development, integration and test of the Aquarius instrument. The Aquarius IM is responsible to the Aquarius PM for meeting the technical performance, cost, and schedule requirements of the instrument.

The Aquarius Observatory Monitoring Engineer (OME) is responsible for monitoring and assessing the risk to NASA of CONAE-provided mission elements. The OME identifies and engages NASA technical experts and MAM for support as potential issues arise. Feedback to CONAE shall comply with U.S. export control regulations.

The Aquarius Ground System Manager is responsible for the development and implementation of the Aquarius Ground System software, hardware and data processing infrastructure that is required to deliver the Aquarius science data products, as well as the instrument command and control system.

The Aquarius Education and Public Outreach (EPO) Manager development of the EPO program and communicating the Aquarius project goals and scientific results through formal and informal education venues.

The key Aquarius project personnel mentioned above represent the Aquarius Level-2 Managers in the Aquarius Work Breakdown Structure (WBS). The Level 2 Managers provide programmatic, budgetary, and technical direction to Level-3 managers, regardless of their home institutions at JPL or GSFC. For example, the Level-2 Aquarius Instrument Manager, residing at JPL, provides direction to the Level-3 Radiometer Manager, residing at GSFC. The Project Manager (Level 1), residing at JPL, provides programmatic, budgetary, and technical direction to the Aquarius Ground System Manager (Level 2), residing at GSFC.

A Lead Coordinator at GSFC will facilitate communication and coordination of GSFC tasks related to financial and scheduling matters during the development and implementation phases for Aquarius. The Lead Coordinator will provide resource administration and schedule information for the radiometer including safety and mission assurance, science including EPO and other science contracts, and ground system. The Lead Coordinator will present Aquarius status to GSFC management at MSR and quarterly reviews. This individual will also participate in the Project MMR and JPL PSR and QSR.

1.1.2 Key SAC-D Project Personnel

The SAC-D PI leads the SAC-D science investigation and is responsible to CONAE for the scientific integrity of the mission and achieving mission success. The SAC-D PI also organizes and leads the SAC-D Science Team including algorithm development. The SAC-D PI delegates day-to-day project implementation authority to the SAC-D PM.

The SAC-D PM will oversee and have authority over the day-to-day management of the project, including mission systems engineering, SMA, and SAC-D payload development. The PM represents the PI in all implementation aspects of the mission. The PM maintains oversight of project activities, ensures timely detection and correction of problems and risks, and analyzes and assesses cost and work progress against plans and schedule. The SAC-D PM is responsible to the PI for overall cost, schedule and technical performance and for risk management. He is responsible for managing project resources, including all budget and schedule reserves, and successfully implementing the project. The SAC-D PM is the primary point of contact with the Aquarius PM during Phases B/C/D.

The SAC-D MSE is tasked with leading a coordinated, comprehensive system engineering effort with support from the MSE Team, which includes the Aquarius PSE. The MSE is responsible for ensuring that the SAC-D project and Aquarius/SAC-D mission will satisfy the SAC-D Level 1 Mission, Level 2A Science Algorithms, and Level 2B Aquarius/SAC-D Mission System. The MSE conducts trade studies and manages SAC-D technical resources. The MSE prepares documentation that communicates and coordinates the activities of system developers.

The SAC-D MAM is tasked with leading a coordinated, comprehensive safety and mission assurance effort with support from the Aquarius SMA team. The MAM manages SAC-D project safety, reliability, quality assurance, and parts. The SAC-D MAM oversees the mission assurance activities at all SAC-D contractor facilities to assure full compliance to the Aquarius/SAC-D mission requirements.

1.2 *Project Policies*

1.2.1 Aquarius Policies Section

The Aquarius project will be managed in accordance with the NASA-CONAE MOU and in compliance with the NASA Policy Guide (NPG) for project management, NPG 7120.5B. Aquarius compliance to NPG 7120.5B is captured in the JPL FPP and *Design, Verification/Validation and Operations Principles for Flight Systems* (DP) compliance matrices. Aquarius has obtained a waiver to the FPP rev. 5 and DP rev. 2 and is attached in Appendix B: Non-Compliance Matrices. JPL is in the process of incorporating 7120.5C requirements. When this process is complete, Aquarius compliance and deviation to the updated DP and FPP will be assessed, and if required, a blanket waiver approved. Any subsequent DP and FPP waivers, if required, will be approved individually.

Aquarius is designed as a NASA Category II mission with a Class C payload. In addition, the Aquarius project is implementing the following policies:

Redundancy: Single-string design with limited block redundancy, providing graceful degradation

Parts: Aquarius Electrical, Electronic and Electromechanical (EEE) parts shall meet or exceed NASA Level 2 parts requirements with selected up-screening

Software: Aquarius Instrument FSW is primarily Class B (Mission Critical)

Mission Cost Summary: Aquarius total mission cost cap is defined in the Level 1 requirements and the details are captured in the Project Plan.

Financial Reserves: Project will hold 30% cost reserves in Phase C/D and 15% in Phase E.

Descopes: Project maintains descope options list with risk, impact, cost and decision point identifiers and is found in Appendix C: Aquarius Descopes.

1.2.2 SAC-D Policies Section

The SAC-D project has voluntarily adopted the JPL FPP (Rev. 5) and DP (Rev. 2) policies. The SAC-D project non-compliances matrices are listed in the SAC-D non-compliance matrices in Section 10.2.2. The SAC-D project policies being implemented include the following:

Redundancy: Service Platform is functional or unit-level redundant. SAC-D Instruments mainly single-string designs with limited redundancy in some areas

Parts: EEE parts shall meet (in most of the cases exceed) NASA Level 2 parts requirements.

Schedule and Resource:

- A centralized database for schedules will be used - Monthly Receivables / Deliverables (Rec/Del) tracking
- Project resources will be reported monthly; adheres to JPL FPP & DP policies

Risk Management: Managed and reported monthly using single database, per Project Risk Management Plan

Descopes: SAC-D PI defines the descope process, options, risk, and impact in the *SAC-D Descope Plan (SD-212-5000)*.

1.3 *Business Section*

1.3.1 Aquarius Business Section

The Aquarius project has established an earned value system to manage work performed with respect to resources expended. The earned value process is consistent with the JPL *Earned Value Management* (EVM) *System Description, Rev. 1*.

GSFC currently does not have an operational EVM system at their institution. GSFC will provide resource management reporting that includes monthly financial, workforce, updated detailed schedules in Microsoft (MS) Project, monthly milestone counts, and Rec/Del reports for the implementation phase. Templates for the milestone counts and Rec/Del reports have been provided to GSFC by JPL.

The GSFC designated PRA will send monthly reports to the JPL Aquarius PRA each month based on the agreed format and contents. At the end of each month, the EVM results from JPL and GSFC resource management reports will be presented at the Monthly Management Reviews (MMR).

1.3.1.1 Work Breakdown Structure

The Aquarius WBS has been tailored to reflect the teaming partnership between JPL, GSFC, and CONAE. The Aquarius WBS was developed in FY02 prior to the release of the JPL Standard WBS. This WBS meets the intent of the JPL Standard Flight Project (SFP) WBS and a waiver has been approved for its use on this project in a JPL Inter-Office Memorandum (IOM) dated 5 April, 2004 [Aquarius-001-2003]. The Aquarius WBS (Level 1 to 3) phase C/D and E are included in Figure 1.3-1. The WBS Dictionary is captured in APIC and in Appendix F: Aquarius WBS Dictionary.

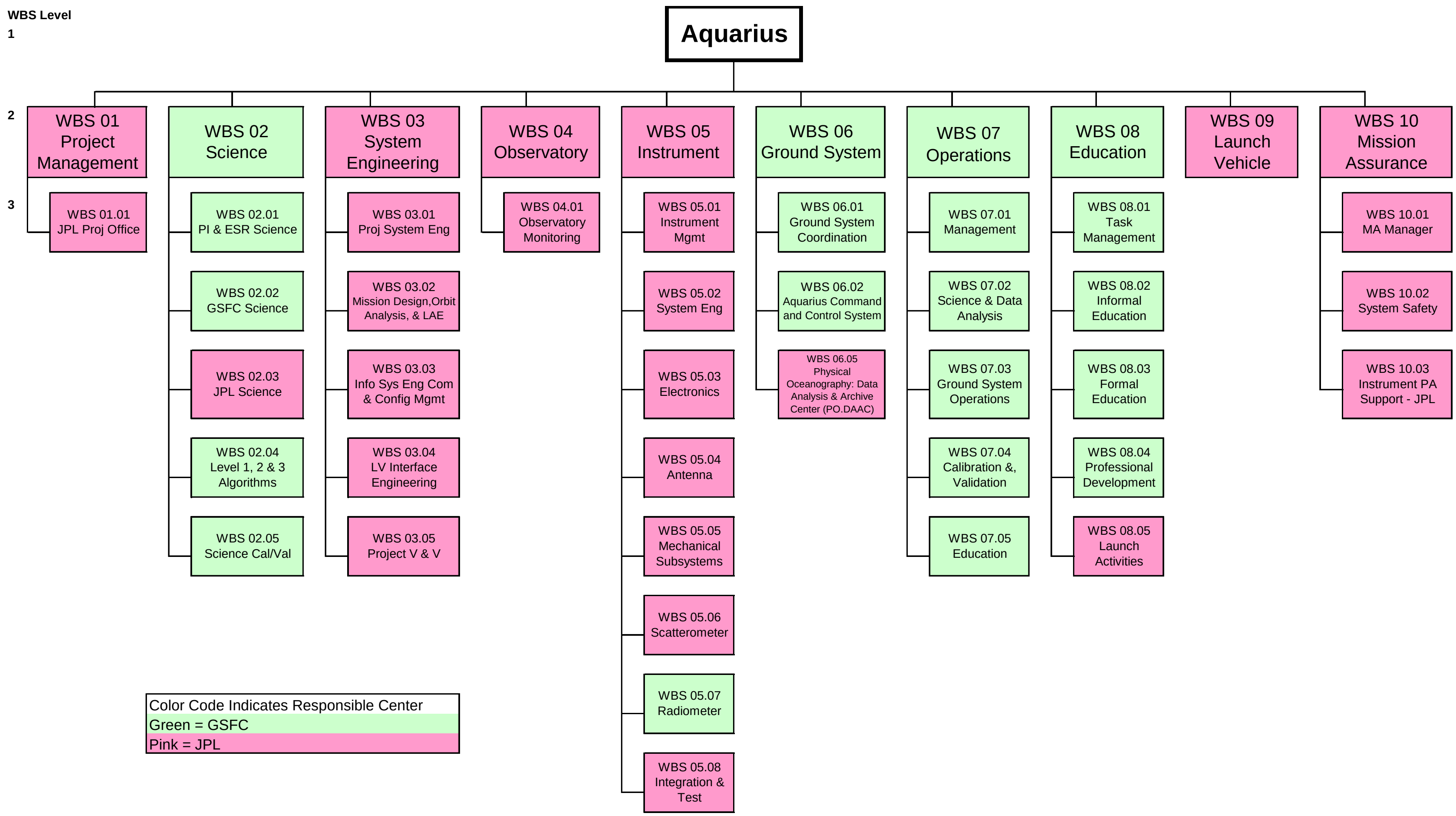

Figure 1.3-1 Aquarius WBS

1.3.1.2 Planning and Control Structure

At JPL, a Resource Management System (RMS) will be put in place that reports on earned value for the Project with the intent of giving advance indications of cost overruns and schedule delays. This system will integrate the functions of funds acquisition and management; project resource planning, scheduling, and cost estimating, budgeting, work agreement; work authorization and delegation; cost accumulation; performance measurement and variance analysis; and incorporation of revisions to baseline plan.

The above mentioned data will be reviewed monthly by Project management. Resource and schedule problems will be identified and corrective action taken at the earliest possible time. Performance assessment will be prepared monthly at Level 2 for all WBS elements except for the Instrument (to Level 3 or 4 as appropriate). Monthly performance assessment will be supported by the following products:

a. Schedules - Baseline vs. Current Working
    1. Top Level — outline of total project, inception to launch
    2. Integration & Test Network — includes vertical deliverables & required dates
    3. Detailed Subsystem Networks — includes vertical deliverables to I&T and horizontal deliverables to other subsystems
    4. Key Milestone Schedules (pre-defined subset of total database)
b. Critical Path analysis
c. Vertical deliverable slack analysis
d. Receivable / Deliverable reporting — includes slack analysis, warning flags, and Cost Account Manager (CAM) metrics
e. A project lien list
f. Plan vs. Actual Activity Start/Finish Metrics (a.k.a., Milestone Count)
g. Earned Value (EV)
    1. Cost Variance (CV)
    2. Schedule Variance (SV)
    3. Cost Performance Index (CPI),
    4. Schedule Performance Index (SPI)
h. Estimate To Complete (ETC) & Estimate At Completion (EAC)
i. Schedule of Key Events

At JPL, the EVM system will be implemented and maintained jointly by the Project Resource Administrator (PRA) and the Project Schedule Analyst (PSA). Using the RMS and the detailed work-to-go schedules, the PSA baselines the schedule and generates Friendly Front End (FFE) templates, the JPL institutional budgeting tool, for each Cost Account (CA). Each CAM then identifies the resource loading required for the scope of work for that CA including workforce, material & subcontracts, service centers and associated burdens resulting in a baseline cost. The baseline schedule and cost is then documented in the Work Agreements (WA) and signed off by the Project and institutional line management as part of the earned value baseline. The WAs are maintained in the Work Agreement System for JPL and in the Aquarius Project

Information Center (APIC) for GSFC. As needed, ETC will be generated using the JPL RMS process.

Based on the process described above, the Project performed a detailed grassroots cost estimate that was approved by the doing organizations at JPL and GSFC. The schedule baseline and process is discussed in the following section, while the resulting baseline cost and workforce can be found in Appendix D: Aquarius Project Cost and Appendix E: Aquarius Project Workforce respectively.

1.3.1.3 Project Schedule Process

The Aquarius/SAC-D scheduling approach is to maintain a "Centralized Scheduling Database" available to all mission partners to ensure baseline integrity for all performance metrics, and provides a single source for all schedule information, metrics, what-if exercises, workaround strategies, and analyses. The Aquarius Project Office will be the point of contact for all project schedule matters. The PSA will generate schedule and milestone reports and information for internal and external reviews. This office will maintain the integrated master schedule throughout the Implementation Phase, coordinating and integrating partners' data with JPL data. JPL will publish the top-level integrated mission schedule as shown in Figure 1.3-2. The centralized scheduling approach does not remove ownership of the schedules from team members, or the institutions they belong to. Each partner is responsible for meeting the key milestones identified in Table 1.3-1.

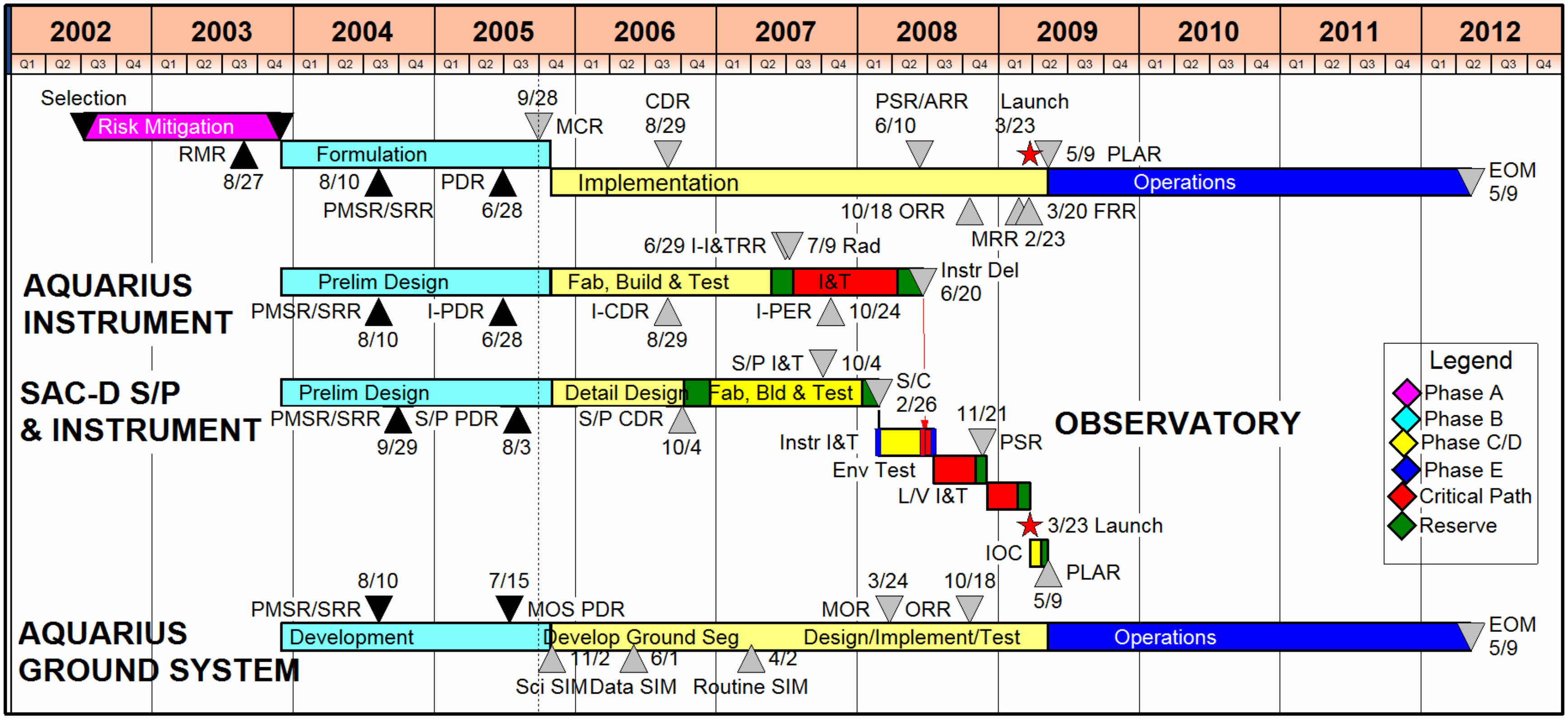

Figure 1.3-2 Aquarius/SAC-D Top Level Schedule

Major Milestones	Current Date
Approval for Formulation	December 1, 2003
NASA-Focus Project Mission and Systems Review / Systems Requirement Review (PMSR/SRR)	August 10, 2004
CONAE-Focus PMSR/SRR	September 29, 2004
NASA-Focus Preliminary Design Review (PDR)	June 28, 2005
CONAE-Focus Preliminary Design Review	August 3, 2005
Confirmation Readiness Review (CRR)	September 20, 2005
Mission Confirmation Review (MCR)	September 28, 2005
NASA-Focus Critical Design Review (CDR)	August 29, 2006
CONAE-Focus Critical Design Review	October 4, 2006
AQ Instrument Integration & Test (I&T) Readiness Review	June 29, 2007
SAC-D I&T Readiness Review (I&TRR)	October 4, 2007
Aquarius Instrument Pre-Environmental Review (PER)	October 24, 2007
Aquarius/SAC-D Mission Operations Review (MOR)	March 24, 2008
AQ Instrument Pre-Ship Review (PSR)/Assembly, Test, and Launch Operations (ATLO) Readiness Review (ARR)	May 20, 2008
Brazil-PSR/PER	June 30, 2008
Observatory PSR/PER	November 21, 2008
Operational Readiness Review (ORR)	October 18, 2008
Mission Readiness Review (MRR)	February 23, 2009
Launch Readiness Review (LRR)	March 20, 2009
Launch	March 23, 2009
Post-Launch Acceptance/Assessment Review (PLAR)	May 9, 2009
End of Aquarius Baseline Mission	May 9, 2012
End of SAC-D Baseline Mission	May 9, 2014

Table 1.3-1 Mission Milestones and Gate Reviews

To establish mission schedule integration, GSFC schedules are integrated via receivables and deliverables and Project Management identified milestones. A Rec/Del is defined as the exchange of hardware, software, firmware, data, documents, etc., between two WBS elements. The schedules contain both Horizontal and Vertical deliverables. Horizontal Rec/Dels are deliveries between subsystems. Vertical Rec/Dels are deliveries to/for Instrument Integration and Testing. This same process will be followed for SAC-D schedule data as it is integrated into the JPL schedule database.

GSFC PSA will provide inputs to the JPL PSA by the end of the first week of each month immediately following fiscal month-end closing. On the second week of every month, the Aquarius PSA and the SAC-D PSA will provide status updates to each other on inter-system Rec/Dels and Project Management identified milestones. The PSA will report the status of the past, present and future month's inter-system Rec/Dels at the MMR.

The schedule database will be maintained in MS Project 2003 (Note: future version updates are to be mutually agreed upon by JPL, GSFC, and CONAE). Reporting schedule metrics will be supplemented using Excel, Visual FoxPro and the BOSS reporting tool. Although all detailed schedule information will originate with the CAMs and subsystem engineers, the schedule network will be integrated and centrally managed by the Project Office under the direction of the Project Schedule Analyst. The Schedule and Budget for Phase C/D are baselined in order to provide monthly schedule status and allow for the generation of schedule metrics.

Each month, in the week following close of the JPL fiscal month, the CAMs and subsystem engineers will meet individually with the Schedule Analyst to update their schedules. When schedule slips occur, an effort will be made to identify workarounds. When all meetings with the subsystem engineers are complete, the updated schedule will be published. Schedule summaries (including reasons for missed milestones) and slack remaining will be presented at the MMR.

The Aquarius project meets JPL DP schedule margin policies as shown in Table 1.3-2. Each subsystem (i.e., antenna, radiometers, scatterometer, Instrument Command and Data Subsystem (ICDS), mechanical and thermal, and Aquarius Power Distribution Unit (APDU)) will hold funded schedule reserves consistent with the JPL DP for Flight Experiment projects. The Instrument I&T schedule will also include DP compliant funded schedule reserve.

	From start of implementation to delivery to Instrument I&T	From start of Instrument I&T to delivery to ATLO	From start of ATLO to delivery to Launch Site	From delivery to the launch site to launch	Total
Total Duration, months	**19.9**	**11.7**	**5.4**	**3.8**	**40.8**
Schedule Margin, months	**1.9**	**2.3**	**1.0**	**1.1**	**6.2**
Schedule Margin Rate, months/yr	**1.1**	**2.4**	**2.1**	**3.3**	**1.8**
DP Schedule Margin Rate, months/yr	**1.0**	**2.0**	**2.0**	**2.7 (1 wk/mon)**	**1.6**

Table 1.3-2 Aquarius Project Schedule Margin

1.3.1.4 Liens Approach

The Project Manager will hold fiscal reserves based on the anticipated risk of development for each subsystem element, with the exception of the radiometer GSFC elements. The fiscal reserves will also take into consideration the rapid turnaround of hardware, software or operational problems that may be identified at Aquarius instrument Integration & Test.

Liens submitted to compensate for expenditures outside of the JPL PEM's approved budget requires Project Manager approval and may consume Project Manager held reserves. The PRA will keep a running list of all liens, amounts and remaining reserve. The annual budget reserves allocated for GSFC work elements will be held by GSFC to enable timely application of reserve without needing to transfer funds from JPL to

GSFC. GSFC will be held accountable for the expenditure of reserves and shall notify the project of any reserve utilization on a monthly basis.

The sponsor is assumed to maintain and control a programmatic implementation reserve for all "changes-of-scope" to the Aquarius Project, i.e. change in assumptions, requirements, deliverables or schedule that is imposed on the project by external organizations or circumstances. The Aquarius Project will submit requests for funds to cover scope changes via a change control request by the Project Manager. Examples of programmatic "changes of scope" are externally-induced schedule changes.

1.3.1.5 Management Reporting

The Aquarius Project Manager convenes a MMR that requires each Level 2 manager to present their element status versus plans for accomplishments, schedule, cost and workforce. EV metrics are presented in order to assess each elements progress. Risks are also identified and statused by each Level 2 manager to ensure their closure. The Project MMRs use electronic conferencing capabilities to include the GSFC element leads and the SAC-D PM.

JPL submits monthly and quarterly (533M and 533Q) financial management reports as described in NPG 9501.2C *Procedures For Contractor Reporting of Correlated Cost And Performance Data* (23 April 1996). Project financial management reports are provided from subcontracts that meet the reporting requirements set forth in *NASA FAR Supplement Section 18-42.7201 (b) (1)*. The Project also provides funding profiles and explains variances between projected and actual costs, as required during project implementation.

Annually, the Project submits data in response to the JPL call for the NASA Program Operating Plan (POP). JPL has a web-based system that supports this annual POP exercise and generates the POP reporting formats required by NASA. For Phase C/D, the POP inputs are coordinated by the JPL PRA and Program Office. Since GSFC assumes the lead center responsibilities during Operations, GSFC PRA will submit the Project POP inputs to NASA and obtain inputs from JPL. In the event of a cost and schedule re-plan, the Aquarius Project Office will issue cost exercise re-plan guidelines.

1.3.2 SAC-D Business Section

The SAC-D project will follow the CONAE policies and procedures in its business activities, according to the statements dictated by the Argentinean Space Program. These same project management policies and procedures were successfully implemented on the SAC-A, SAC-B and SAC-C projects.

1.3.2.1 SAC-D Work Breakdown Structure

The SAC-D WBS shown in Figure 1.3-3 aligns well with the Aquarius WBS to promote collaborative communication and cooperation. The WBS represents the approved scope of work consistent with CONAE's agreements and funding capabilities.

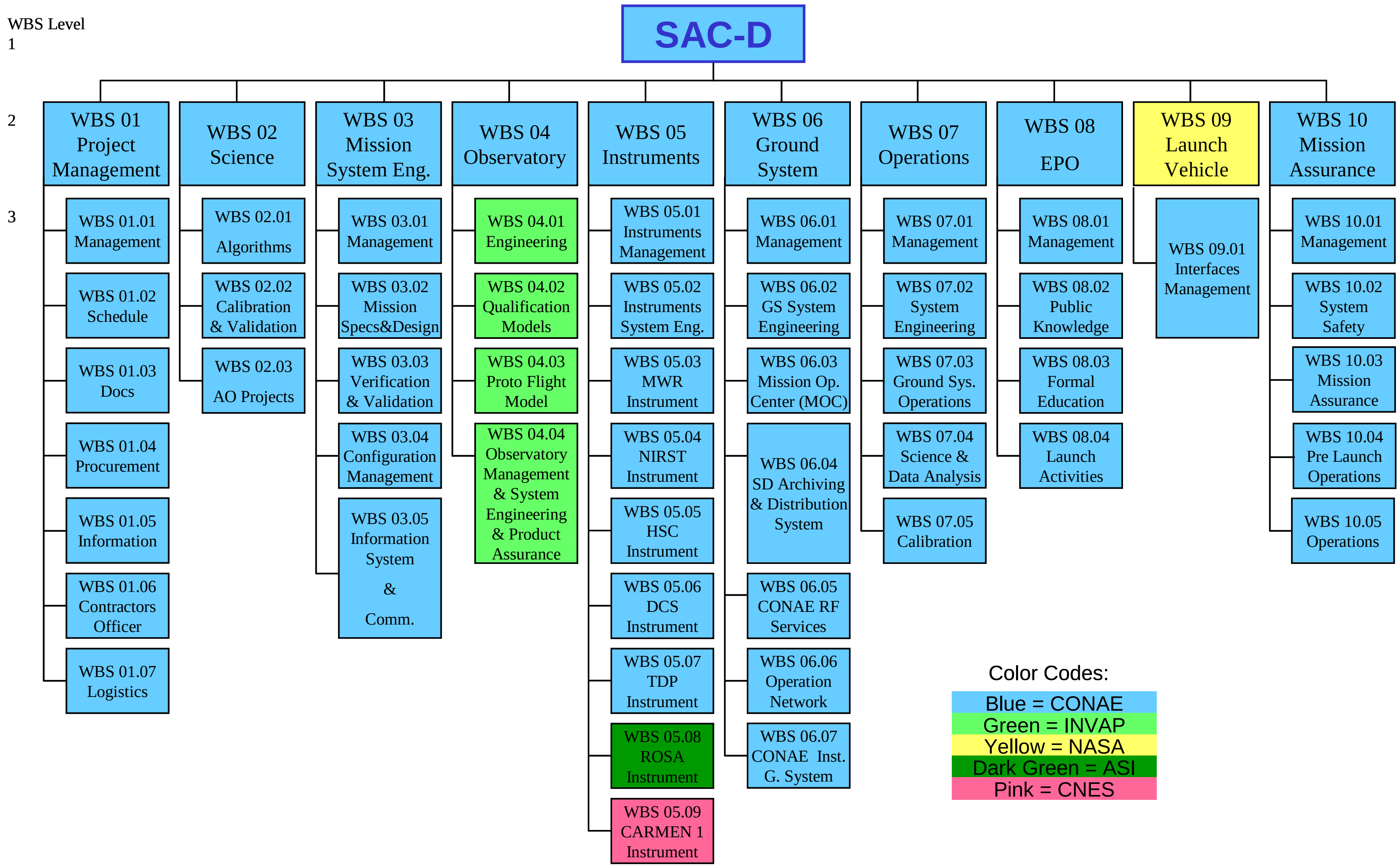

Figure 1.3-3 SAC-D Work Breakdown Structure

1.3.2.2 Planning and Control Management

CONAE's upper management has approved the SAC-D management plans and schedules. The plans and schedules are consistent with the agreements made with Aquarius, CONAE and other 3rd party instrument providers. The associated cost will be managed according to CONAE's budget and funding capabilities.

CONAE upper management requires the SAC-D PM provide quarterly cost and schedule assessments between planned versus actual performance to assess how well the SAC-D project is progressing.

SAC-D Project schedules will be comprised of milestones and deliverables schedules, jointly integrated with JPL, GSFC, Agenzia Spaciale Italiana (ASI) and Centre National d'Etudes Spatiales (CNES).

1.3.2.3 Work Control

The SAC-D Project Manager is responsible for submitting and obtaining approval from CONAE's upper management for any scope changes. This requirement applies especially to deliverables and receivables, schedules, and costs that are in excess of their commitments and assigned resources.

The baseline plan will remain fixed unless a change in scope or other impact causes the plan to become outdated as a tracking mechanism. The Project Manager will maintain a budget baseline log to account for changes, and the foreseen changes in cost-scope-schedules will be reported to the CONAE's Program Manager Office to obtain the corresponding authorization to proceed.

1.3.2.4 Project Schedule Process

The SAC-D PSA, working inside the SAC-D Project Office, will maintain the integrity of the project schedule on a monthly basis. The schedule and associated Rec/Del information shall be available to all team members in the SAC-D Project. The SAC-D PSA also shall be responsible for the completeness and accuracy of the project Rec/Del list.

On the second week of every month, the Aquarius PSA and the SAC-D PSA will provide status updates to each other on inter-system Rec/Dels and Project Management identified milestones as discussed in Section 1.3.1.3.

The SAC-D PSA will maintain, for analyses purposes, an account level list of all project Receivables and Deliverables. A sub-list of all "un-matched" receivables and deliverables will be published each quarter identifying the source, the unacknowledged receivable or deliverable and the account for which paternity is alleged but not acknowledged.

1.3.2.5 Resource Administration

The SAC-D Project Manager is responsible for administration of all project resources using a variety of CONAE's institutional tools, systems and processes, matching the project necessities with CONAE Program Management directives.

Budget estimation, submittal, approval, and baseline tracking are the core project activities for resource administration.

1.3.2.6 Management Reporting

The SAC-D Project Manager will participate in Aquarius MMRs as described in Section 1.3.1.4, and report monthly metrics as a key element of the cooperative monitoring process, so that the Aquarius Project and NASA have early warning of potential SAC-D mission development problems and risk areas. The metrics are defined in the *Cooperative Monitoring Plan (AS-314-0015)*. The Aquarius Project will in turn provide monthly metrics to the SAC-D project as part of the MMRs, so that CONAE can have early warning of potential Aquarius development problems and risk areas.

1.4 *Implementation Mode*

1.4.1 Aquarius Implementation Mode

The Aquarius Project implementation strategy is summarized in the table below and discussed in further detail in the accompanying sections.

Responsibility	Responsible Organization	Implementation Mode
Project Management	JPL	In-house
Mission Science	GSFC	PI Contract with ESR, Proj. Scientist at JPL
Mission Systems Engineering	JPL	In-house
Mission Assurance	JPL	In-house; GSFC on radiometer development
Instrument Management, SE, Scatterometer & Subsystem Development	JPL	In-house with sub-contracts (e.g. reflector)
Radiometer Development	GSFC	In-house
Instrument I&T and Environmental Tests	JPL	In-house
Observatory Monitoring	JPL	In-house
Science Algorithm Development & Cal/Val	GSFC	Contract with RSS & Univ. of Michigan
Aquarius Mission Operations	GSFC	In-house
Science Data Processing	GSFC	In-house
Archiving & Distribution	JPL	In-house

Table 1.4-1 Aquarius Project Implementation Mode

1.4.2 SAC-D Implementation Mode

The SAC-D Project implementation strategy is summarized in the table below and discussed in further detail in the accompanying sections.

Responsibility	Responsible Organization	Implementation Mode
Project Management	CONAE	In-house
Mission Systems Engineering	CONAE	In-house
Mission Assurance	CONAE	In-house
SAC-D Instruments	CONAE	Instrument Contractors (INVAP, Others) / Third-party Contributors (ASI, CNES)
SAC-D Service Platform	CONAE	Prime Contractor (INVAP) / Subcontractors for selected Components
Observatory Integration & Testing	CONAE	Prime Contractor (INVAP) / INVAP Facilities in Bariloche (Argentina)
Observatory Environmental Testing	CONAE	Prime Contractor (INVAP) / INPE/LIT Facilities in Brazil
Observatory Mission Operations	CONAE	In-house / Contractors At Córdoba (Argentina) Ground Segment
Science data acquisition, processing, archiving & distribution	CONAE	In-house / Contractors At Córdoba Ground Segment and Data Services Center

Table 1.4-2 SAC-D Project Implementation Mode

1.5 *AS Mission Review Plan* *(AS-211-0166)*

The Aquarius/SAC-D Mission has defined a rigorous and comprehensive review process which is detailed in the *Aquarius/SAC-D Mission Review Plan.*

For Mission-level reviews and Aquarius System-level reviews, the Standing Review Board (SRB) will be an Independent Review Team (IRT) that combines the objectives of major milestone reviews and the typical independent reviews required by NASA NPR 7120.5C. The IRT, including the co-Chairs (one from JPL and one from GSFC), has been selected and confirmed by the JPL Director for ESTD, GSFC Director of Earth Sciences, and the ESSP Program Manager in concurrence with CONAE. The IRT will consist of members that are entirely independent of project advocacy. Members of the IRT may come from NASA, CONAE, JPL, industry, academia, and independent consultants. The IRT will conduct the major Mission-level reviews: PMSR/SRR (NASA and CONAE focus), PDR (NASA and CONAE focus), CDR (NASA and CONAE focus), ARR, ORR, PSR, MRR and PLAR; and if required, report their findings to the JPL and GSFC GPMC's. See Figure 1.5-1 for the location and pictorial of the major Mission-level reviews. In addition, the IRT co-Chairs will participate in the Confirmation Reviews, CRR and MCR. The IRT will also participate in Aquarius and SAC-D System-level reviews, as required.

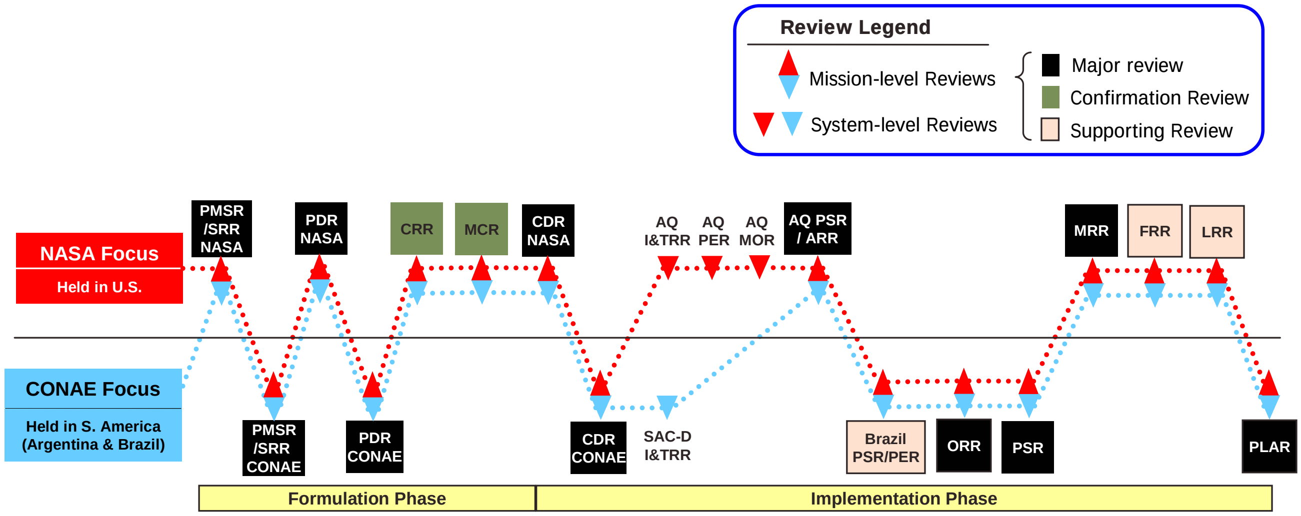

Figure 1.5-1 Mission and System-level Reviews and Location

1.6 *AS Risk Management Plan* (*AS-213-0091*)

The Aquarius/SAC-D Mission has defined its approach to risk management in the *Aquarius/SAC-D Risk Management Plan*.

The Aquarius and SAC-D Project Managers are responsible for the risk management process for the Aquarius/SAC-D Mission, but the process is implemented using the coordinated efforts of the full Aquarius and SAC-D project teams. The Aquarius PSE and the SAC-D MSE are the responsible Risk Management Engineers (RME) for their respective projects. The RMEs implements the risk management process, coordinates identification and status of risk throughout the team, and tracks and reports on risk management metrics. Figure 1.6-1 shows the overall flow of the risk management process and its relationship to the risk status and the risk approach.

Each risk will be mapped on the NASA 5 x 5 Risk Assessment Chart, Figure 1.6-2 on the associated Green, Yellow or Red area associated with its Likelihood versus Consequence rating. Green risks do not represent a mission threat. Yellow risks represent a potential threat to mission success. Red risks represent significant and likely threats to mission success. Each risk will be assigned rating of potential consequences and likelihood of occurrence according to the criteria shown in Table 1.6-1.

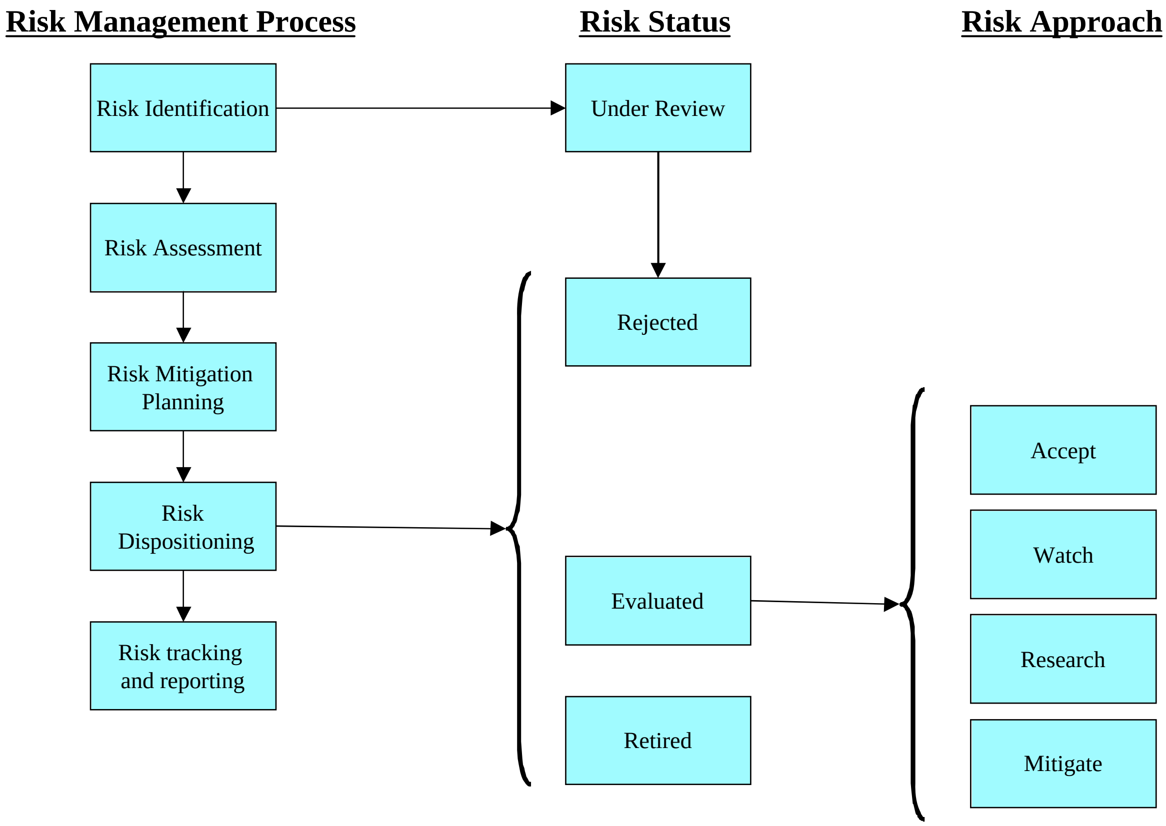

Figure 1.6-1 Aquarius/SAC-D Risk Management Process

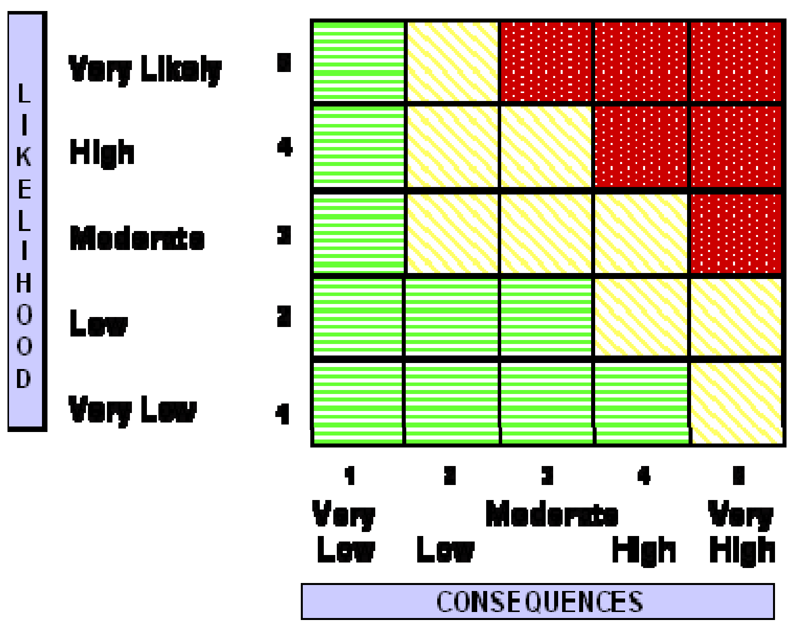

Figure 1.6-2 NASA 5 x 5 Risk Assessment Chart

Consequence categories: (Technical, Schedule, Cost)	Likelihood categories:
5 Very High -Loss of Observatory, primary instrument(s) or injury to personnel -Cannot meet minimum mission success criteria. No alternatives exist - Major impact to critical path and can not meet major milestone - Greater than 15% increase over allocated budget and/or exceeds available reserves	**5 Very High** - Almost certain, 70-100%
4 High - Major impact to full mission or technical success criteria, but still meet minimum mission success/exit criteria, threatens established margins. - Significant impact to critical path schedule, and can not meet established lower level milestones - Between 10% and 15% increase over that allocated budget, and/or threatens to reduce reserves below prudent levels	**4 High** - More likely than not, 50-70%
3 Moderate - Moderate impact to full mission success, but can be handled within established margins. - Impact to critical path schedule, but can be accommodated by schedule reserves - Between 5% and 10% increase over allocated budget, and can be handled within available reserves	**3 Moderate** - Significant likelihood, 30-50%
2 Low - Minor impact to full mission or technical success criteria, but accommodated with established margins. - Minor schedule impact, but accommodated within schedule reserve; no impact to critical path - Between 2% and 5% increase over that allocated budget and can be accommodated with available reserves	**2 Low** - Unlikely, 1-30%
1 Very Unlikely - Minimal or no impact to full mission success - Minimal reduction in schedule reserves - Less that 2% increase over allocated budget, and accommodated within available reserves	**1 Very Unlikely** - Very unlikely, <1%

Table 1.6-1 Risk Consequence and Likelihood Categories

1.7 *Acquisition Planning*

1.7.1 AQ Acquisition and Surveillance Plan (AQ-211-0126)

The Aquarius Project's acquisition approach, strategy and activities are documented in the *Aquarius Acquisition and Surveillance Plan*.

The JPL Acquisition strategy is driven by the plan to subcontract design and development of the High Gain Antennae (HGA), Antennae Feed Assembly, and the Front-End and Back-End electronics for the scatterometer subsystem. The HGA will be awarded competitively and the remaining major subcontracted scatterometer subassemblies will likely be non-competitive awards, due to the scarcity of capable suppliers. The system level design, development, I&T are the responsibility of JPL-in-house organizations.

The surveillance role will be performed by the subsystem Cognizant Engineer. Surveillance activities include but are not limited to weekly status reports; monthly review of SDRL deliverables and hardware delivery status; Peer Review; and review and assess the subcontractor's performance and report that assessment back to the Project, JPL Acquisition management and the subcontractor.

1.7.2 SAC-D Acquisition Plan (SD-211-0042)

The SAC-D Project's acquisition approach, strategy and activities are documented in the *SAC-D Acquisition Plan*.

1.8 *AQ Export Control Plan (AQ-211-0187)*

Aquarius describes how the Project will comply with Export Control policies, requirements, and procedures in the *Aquarius Export Control Plan*.

In addition, a Technical Assistance Agreement (TAA) was signed on July 12, 2004 between JPL and CONAE to ensure JPL-institutional compliance with International Traffic in Arms Regulation (ITAR). The TAA contains the following topics:

Technology Transfer: No technology transfer required by the Project.

Foreign Nationals: Follow Institutional guidelines and document project-specific plans in the Aquarius TAA; Institutional policies for Foreign Visitor control including e-access are in effect.

Facility Access: Comply with Institutional policy and document any unique access requirements in the Aquarius TAA.

Recordkeeping Plan: All technical interchanges (including meeting attendance and notes) are logged and archived. Shared records are kept in the Export Controlled (EC) approved area in the JPL APIC, e-mail correspondence is archived; e-archive planned for the mission life. Document marking policy has been established. Mandatory personnel training is in effect by the institutional International Office.

Licensing: JPL TAA for CONAE has been approved by US State Department. License is not required for GSFC.

Transport and Shipping of Hardware: Obtain Temporary Export License for the shipment of hardware to Argentina and Brazil for I&T, by CDR

Travel: All international travel are forecasted and approved by Project Manager, Export Control Office (JPL OLIA), Security, Center Management and by the NASA HQ Program Office.

1.9 *AS Crisis Response Plan (AS-211-0260)*

The Aquarius/SAC-D mission has developed a joint document to define those situations or events that are considered crises along with the required actions by project members (JPL/GSFC/ CONAE, contractors, and all other Project participants). The *Aquarius/SAC-D Crisis Response Plan* complies with NPR 8621.1A, *NASA Procedures and Guidelines for Mishap Reporting, Investigating, and Record Keeping* which provides detailed guidance concerning how to respond to any mishap or close call from discovery through closure of the actions needed to prevent recurrence, how to release that mishap information to the public, how to appoint investigation review boards, and data analysis techniques to be used in investigations.

1.10 *Logistics Section*

1.10.1 Product Delivery

With the distributed development activities for Aquarius and SAC-D, there is an overall logistics perspective related to shipment of equipment, and where tests will be performed. The overall transportation of equipment is shown in Figure 1.10-1 followed by a table summarizing the required facilities and institutional support required for the mission.

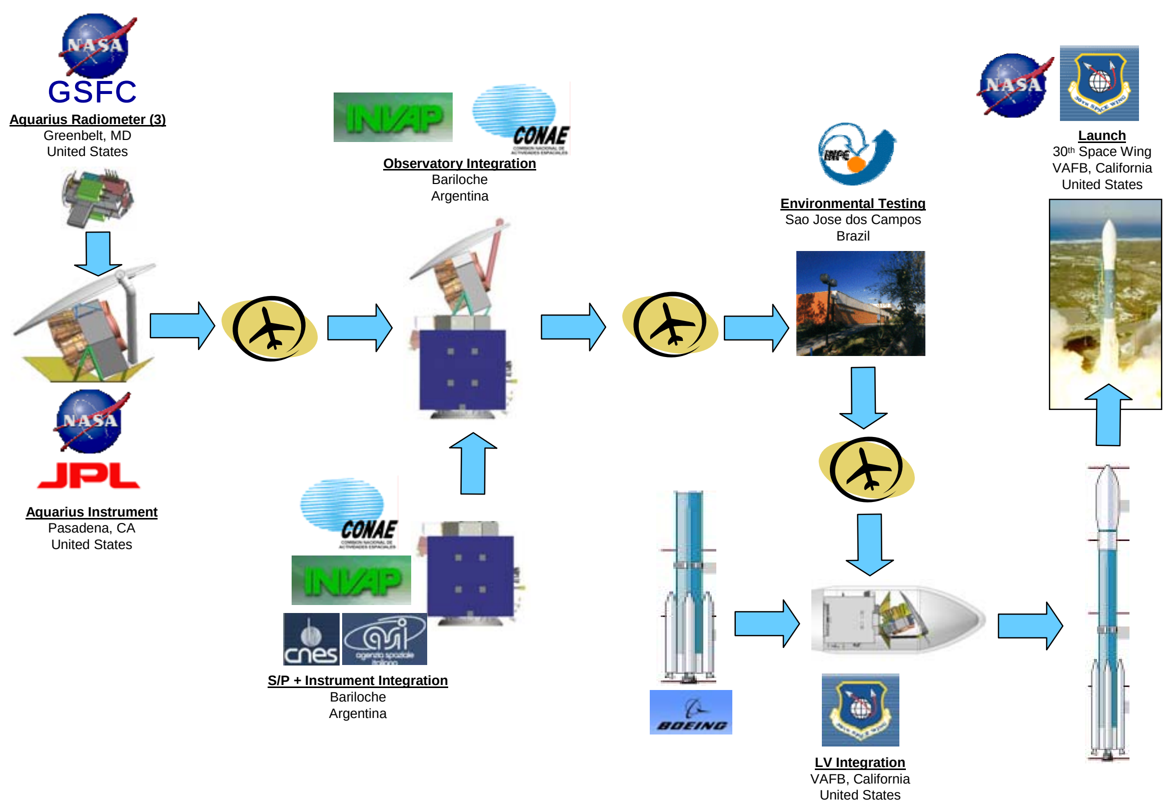

Figure 1.10-1 Project Logistics for Equipment Transfers

Organization	Facility	Mechanisms To Ensure Availability
JPL	Environmental Test Laboratory Antenna Test Facility ADADS Science Data Repository	Facilities Plan
GSFC	Microwave Instrument Lab Instrument Development Lab Environmental Test Engineering and Integration Lab Aquarius Data Processing Segment NASA/GSFC Polar Ground Network	Facilities Plan
Earth and Space Research (ESR)	Aquarius Data Validation Segment	Grant/Contract
CONAE	Ground Station Antennas (S- and X-Band) and SAC-D Ground Ops System, Córdoba, Argentina	NASA-CONAE MOU
INVAP	I&T Facilities in Bariloche, Argentina	Contract between CONAE & INVAP
INPE (Brazil)	Environmental Test Facilities (Sao Jose dos Campos, Brazil)	Co-operative agreement between Brazil & Argentina
USAF/Boeing	WR	KSC/MOU

Table 1.10-1 Facilities and Institutional Support

In the initial development stage, JPL, GSFC, CONAE, and Investigaciones Aplicadas (INVAP), the prime contractor for CONAE, will be establishing the detail designs, fabrication, and assembly and testing of their respective elements based on their responsible deliverables. GSFC is developing the radiometer and the Aquarius Ground System. The first major equipment transfer, associated with Aquarius, will be GSFC delivering the fully flight-qualified radiometer, and any associated ground support equipment, to JPL. JPL will integrate the radiometer onto the Aquarius Instrument with the scatterometer, antenna, and other subsystem elements. Primary calibration and testing of the Aquarius equipment will occur at JPL. Once completed, the Aquarius Project will ship the flight-qualified instrument and associated equipment to CONAE in Argentina for integration into the SAC-D Observatory. The Aquarius/SAC-D Observatory will then be transported by SAC-D to Sao Jose dos Campos, Brazil for Observatory environmental testing and then to Vandenberg Air Force Base (VAFB) for launch activities.

Aquarius, SAC-D and 3rd party instrument providers will send qualified personnel to support the integration and test activities at each location: Argentina, Brazil, and VAFB as necessary.

Transportation in and around the VAFB facility will be provided by NASA/KSC (Kennedy Space Center), the organization responsible for ground processing at the launch site, and/or Boeing Operations, the organization providing the Delta II 7320-10C launch vehicle.

1.10.2 Flight Hardware Logistics Program

The Aquarius project is receiving residual RAD6000 flight computers hardware from the JPL Flight Hardware Logistics Program (FHLP) based on MOU signed 8 April, 2004. The project has inherited the Mars Exploration Rover (MER) RAD6000 flight spare, both engineering models, and a breadboard. However, as long as Spirit and/or Opportunity are functional, Aquarius will not have access to the engineering models.

1.10.3 Spares Philosophy

1.10.3.1 Aquarius Spares Philosophy

The Aquarius spares philosophy is based on a minimum cost, consistent with a soft launch window and built-in funded schedule reserve. Sparing is done at the piece part level for all electronic parts. No sparing at the assembled board or box level is planned. No flight spares of mechanical structure or mechanisms are planned. A 30-45 working day window is the planned period for sparing replacement at all Aquarius instrument subsystems prior to Observatory level integration.

1.10.3.2 SAC-D Spares Philosophy

The SAC-D spares philosophy involves the following:

- Parts procurement includes EEE & PC-board spares. Also applies to Solar Array (i.e., space qualified solar cells and cover-glasses), S- and X- band antennas, Battery cells and Propulsion valves and thruster modules.
- No spares for main components are foreseen (i.e., S-band transceivers, X-band transmitters, reaction wheels, star trackers, gyros, GPS receivers, battery, and propulsion tank).
- Qualification Models (Engineering Model after specific qualification program) could be considered as spares at component level in cases where schedule is a constraint.

1.11 *JPL-GSFC Operations Transition Plan (AQ-211-0261)*

The *JPL-GSFC Operations Transition Plan* documents the transfer of project management responsibility from JPL to GSFC at the end of the Implementation Phase. The transition will be completed after successful completion of on-orbit checkout and the PLAR (which will also serve as a Handover Review), and all significant issues are adequately addressed. Figure 1.11-1 represents the current organization of the Aquarius/SAC-D mission during Operations. The GSFC roles and responsibilities during Operations are summarized in Table 1.1-1 Aquarius/SAC-D Mission Partner Roles and Responsibilities.

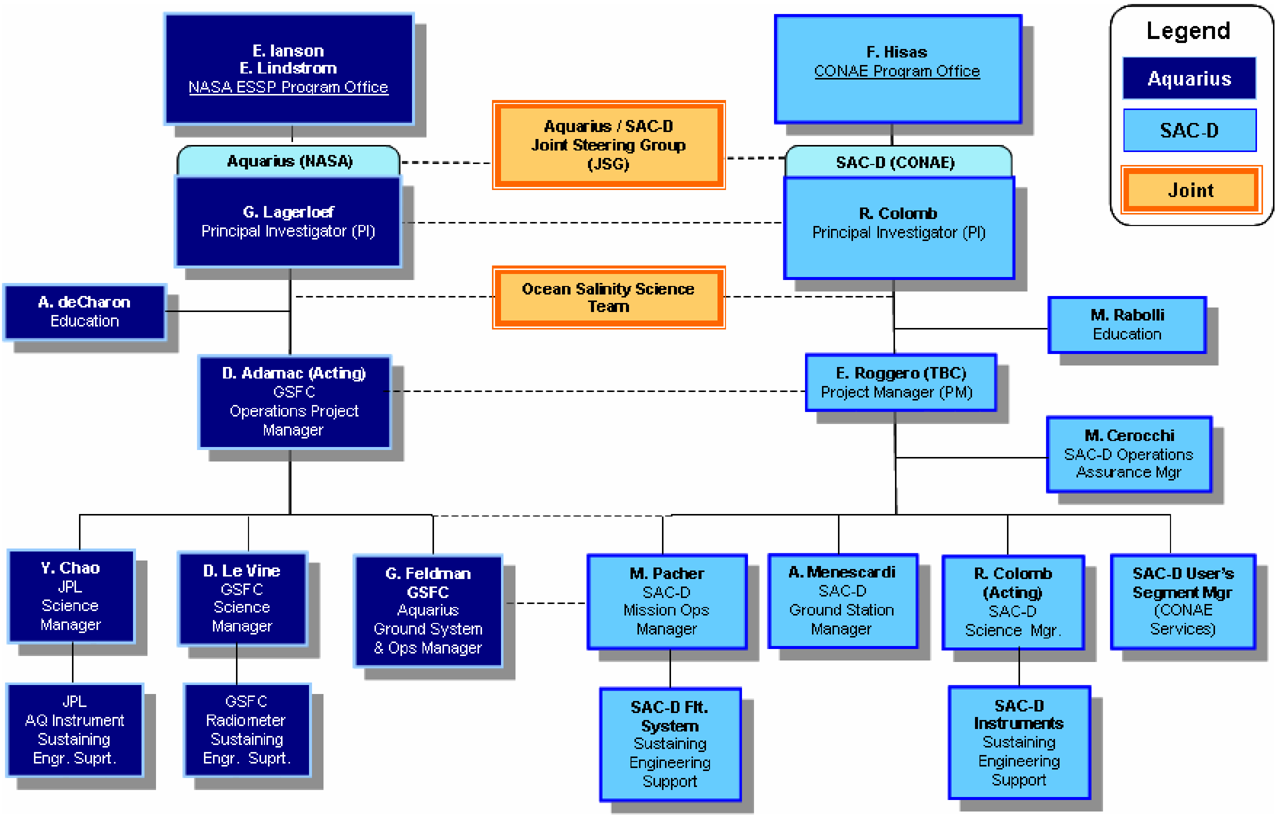

Figure 1.11-1 Aquarius/SAC-D Mission Operations Phase Organizations

2 Science Implementation Planning

2.1 *AQ Science Management Plan* *(AQ-212-0189)*

The Aquarius project defines the Aquarius science team roles and responsibilities throughout the project life in the *Aquarius Science Management Plan*.

The PI and Science Team will participate in the development and review of long-term baseline observation strategy prior to launch. The team will collect datasets acquired by instruments on the ocean surface, towed by ships, and flown in aircraft that can be used to validate Aquarius retrievals. The team will develop and execute a data validation strategy that compares measurements based on these data sets with those based on retrievals from Aquarius. The team will develop a strategy to calibrate instrument measurements in flight.

After launch, the PI (or his designee) will oversee mission operations activities. The PI will coordinate data validation and data calibration activities with the Science Team. They will establish procedures that ensure the quality of Aquarius data products. The PI, Science Team, and Aquarius Ground System will participate in weekly operations meetings that establish upcoming observational sequences and specify modifications to routine operations. The team will regularly review operations plans and propose modifications based on the content and quality of data and to take advantage of any special observing opportunities.

2.1.1 Aquarius Science Data Collection, Analysis, and Archive Section

During operations, the Aquarius instrument will continuously collect observations except for brief periods of time when orbit maintenance maneuvers or off-nominal instrument calibration is required (approximately every month). The Aquarius science investigation team will continually monitor the received and processed science data and test additional adjustments of the data based upon new local observations or calibration parameters received from the instrument. If those adjustments are deemed to be an improvement, they will be inserted into the processing system, and the entire Aquarius science data set will be reprocessed with the new parameters or equations.

2.2 *SD Science Management Plan (SD-212-0083)*

The SAC-D project defines the SAC-D science team roles and responsibilities throughout the project life in the *SAC-D Science Management Plan*.

3 Project Systems Engineering Implementation Planning

3.1 *AS System Engineering Implementation Plan (AS-213-0093)*

The *Aquarius/SAC-D System Engineering Implementation Plan* (SEIP) identifies and describes the integrated mission system engineering organization, roles and responsibilities, overall tasks, formal and informal communication channels, requirements identification, mission interfaces, design trade study and analysis processes, verification and validation plan formulation and management, and technical risk and resource management required to implement and manage the design, development, fabrication, and testing associated with the Aquarius/SAC-D Mission.

The policies regarding the Aquarius/SAC-D mission technical resources and margins; including how margins are calculated and the margin levels to be maintained and tracked throughout the mission life cycle is captured in the *Aquarius/SAC-D Technical Resource and Margin Plan (AS-213-0089)*.

3.1.1 SD Observatory Systems Engineering Implementation Plan (SD-314-0201)

Overall INVAP system engineering roles and responsibilities, processes and methods to be used during the implementation phase are documented in the *SAC-D Observatory Systems Engineering Implementation Plan*.

3.2 *Software Management Section*

Each major partner associated with the Aquarius Instrument and SAC-D Service Platform (JPL, GSFC, and CONAE) will develop a Software Management Plan (SMP) consistent with their institutional standards and management practices. These Software Management Plans will serve as the controlling document for software planning, cost estimation, requirements analysis, design, development, reviews, testing, delivery, metrics collection, and process audits.

Although the emphasis is on following institutional standards, consistency across the Aquarius/SAC-D mission is necessary to ensure work products can be exchanged between Aquarius/SAC-D partners. Thus, a core set of capabilities shall be addressed in each SMP and subordinate software documentation identified as noted below. These core capabilities and subordinate documentation are relatively standard for software activities and shouldn't be outside the normal development practices.

As a minimum, each SMP shall address the software topics listed below.

- Roles and responsibilities
- Development planning
- Reviews
- Requirements development and management
- Architectural design
- Detailed design
- Development
- V&V plans
- Delivery, associated user guides, and release notes
- Maintenance and post-delivery support

The SMP shall define the software products to be developed for the program. As a minimum, this shall include the software information listed below.

- Requirements Analysis
- Architecture Design
- Detailed Design
- Test Requirements/Plan
- Test Procedures

Each SMP shall define the activities to be performed by Software Quality Assurance (SQA). As a minimum, SQA shall evaluate the software processes at the beginning of development and then re-evaluate them periodically to ensure that the processes support the product quality objectives. These process evaluations shall also include audits of the associated work products.

3.2.1 Aquarius Software Management Plans

Aquarius software management plans address the flight software being developed at JPL and the ground software modifications at GSFC.

Each SMP shall identify the major software units/modules and the associated mission classification (A-human-rated, B-mission critical, C-mission support, and D-development support/technology). This classification shall be reviewed by the Aquarius and SAC-D Mission Assurance Manager and PSE/MSE for approval (reference *JPL Software Classification [DocID: 71692])*.

The PSET and SMA team will verify consistency of SMP processes with project-level documents (e.g., configuration management and V&V) as part of the approval process.

3.2.1.1 Aquarius Flight Software Management Plans

The Software Management Plans for Aquarius flight software development being performed at JPL shall follow the SMP template consistent with the *Software Development Requirement* (SDR)*, revision 5 (JPL D-23713, DocID 57653)*. SMPs shall be reviewed for consistency regarding software deliveries to the instrumentation team.

There will be two SMPs for Aquarius Flight Software: the *Instrument Command and Data Subsystem Flight Software Management Plan* *(AQ-515-0234)* and the *Aquarius Active Thermal Control (ATC) Software Management Plan* *(AQ-515-0246).* The major software functionality and associated classification for the ICDS, ATC, and associated ground support equipment (GSE) are provided in the individual SMPs.

3.2.1.2 Aquarius Ground System Software Management Plan (AQ-316-0239)

The Aquarius Ground System is being developed from an existing and currently operational data processing system. GSFC will utilize institutional guidelines for generating the SMP, but since both the Aquarius Ground System elements and the JPL Physical Oceanography: Data Analysis and Archive Center (PO.DAAC) are existing systems; the *NASA Software Engineering Requirements document (NPR 7150.2)* is not applicable to this document.

3.2.2 SAC-D Software Management Plans

The SAC-D software management plan addresses flight software being developed by INVAP. The SAC-D ground system does not have a separate plan since the majority of the software is inherited and any modifications will follow the processes developed from previous missions.

3.2.2.1 Service Platform Software Management Plan (SD-213-0046)

The *Service Platform Software Management Plan* will follow the applicable CONAE regulations and requirements. Their software development efforts are mainly based on European Cooperation for Space Standardization (ECSS) Software engineering standards as identified in the table below. Other standards, procedures, and guides are considered for selected cases.

MANDATORY	
Software Engineering	• ECSS-E-40 Part 1B Space Engineering - Software – Part 1: Principles and Requirements (28 November 2003) • ECSS-E40 Part 2B – Space Engineering – Software – Part 2: Document Requirements Definitions (DRDs) 31 March 2005
Software Product Assurance	ECSS-Q-80B Space Product Assurance – Software Product Assurance
RECOMMENDED	
Software Development Methodology	Ward & Mellor
Coding (Only for C programming)	Estándar de Codificación y Estilo para el Software de Plataforma de SAC-D (internal document)
V&V	IEEE Std. 1012, Standard for Software Verification and Validation Plans
Additional Testing	IEEE Std. 1008, Standard for Software Unit Testing and IEEE 829 – 1991 Standard for Software Test Documentation
SW Configuration Management	• ECSS-M-40B Space Project Mgmt - Config Mgmt (20 May 2005) • IEEE Std. 828, Standard for Software Configuration Management Plans • IEEE Std. 1042, Guide to Software Configuration Management

Table 3.2-1 SAC-D Software Development Specifications and Guidelines

3.2.2.2 SAC-D Ground System Software

The SAC-D Ground System in Cordoba, Argentina is being developed from an existing and currently operational system. CONAE will utilize the same institutional guidelines, policies, and procedures for software management for any software modifications deemed necessary.

3.3 *Information, IT, and Configuration Management Planning*

During the Implementation Phase, an Engineering Change Request (ECR) process will be implemented. The ECR process will first be used to track the changes in the released documents and requirements. The requirements will be under configuration control once the requirements are released in hierarchical order, starting with Level 1 requirements (at MCR for Aquarius). Summary status reports will be provided CONAE for Aquarius Change Control Board (CCB), and summary status reports will be provided Aquarius for SAC-D CCBs. For joint documents, a joint CCB will be lead by Aquarius since the Aquarius project will maintain a Master Control Data List (MCDL) for all Aquarius and joint Aquarius/SAC-D documents as specified in the SEIP. GSFC and SAC-D specific documents will be controlled and maintained at GSFC and SAC-D using their internal CM process and will not be listed in the JPL MCDL.

3.3.1 AQ Information, IT and Configuration Management Plan (AQ-213-0085)

The *Aquarius Information, Information Technology (IT), and Configuration Management (IICM) Plan* describes the implementation of information management, configuration management, and the IT environment for the Aquarius Project, in accordance with the

JPL Flight Project Practices, applicable regulations, and other JPL and Project requirements.

3.3.2 SD Information Management Plan (SD-213-0045)

The *SAC-D Information Management (IM) Plan* describes the implementation of information management and the IT environment for the SAC-D Project, in accordance with the applicable CONAE regulations and requirements.

3.3.3 SD Configuration Management Plan (SD-213-0022)

The *SAC-D Configuration Management Plan* describes the CM responsibilities and processes that support the design and implementation of the Aquarius/SAC-D Observatory. The purpose of the document is to identify the organization providing the configuration control, define what a configuration-controlled item is, describe the change control process, and identify the plan for configuration status accounting and verification.

3.4 *Contamination Control Planning*

3.4.1 AQ Instrument Contamination Control Plan (AQ-215-0106)

The Aquarius project has developed an *Aquarius Instrument Contamination Control Plan*. The scope of the plan includes all phases of assembly, test, transportation, and launch of the Aquarius instrument.

3.4.2 SD Observatory Contamination Control Plan (SD-314-0049)

The *SAC-D Observatory Contamination Control Plan* defines the general contamination control requirements that each Observatory element must implement under their own provisions and responsibilities. The contamination control plan and procedures of partners, contractors and subcontractors responsible for the provision of instruments / components, service platform and Observatory I&T activities, shall be consistent with the philosophy and approach to contamination control as defined in this document.

3.5 *Materials and Processes Control Planning*

3.5.1 AQ Materials and Processes Control Plan (AQ-315-0193)

To ensure proper selection and utilization of materials and processes to meet the Aquarius Instrument functional, reliability, mission environment and safety requirements, Aquarius has developed an *Aquarius Materials and Processes Control Plan*.

3.5.2 SD Materials and Processes Control Plan (SD-314-0053)

The *SAC-D Materials and Processes Control Plan* defines the plan for managing all mechanical parts, materials, and processes for the SAC - D project. It delineates the information needed to be collected for the parts, materials, and processes, and the criteria by which they will be evaluated.

3.6 *AQ NEPA Compliance Document (AQ-283-0096)*

Based on the Aquarius/SAC-D mission baseline description, compliance with National Environmental Policy Act (NEPA) review requirements will be satisfied by qualification of Aquarius/SAC-D as a NASA Routine Payloads under the "Final NASA Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force station, Florida and Vandenberg Air Force Base, California." This assessment has been captured in the *Aquarius NEPA Compliance Document*.

3.7 *AQ Orbit Debris Limiting Assessment (AQ-363-0100)*

As specified in the *Aquarius Orbit Debris Limiting Assessment*, the Aquarius project is responsible for assessing the orbital debris for the Aquarius Instrument and Launch Vehicle in compliance with the policies and practices established in *NASA Policy Directive (NPD) 8710.3B, NASA Policy for Limiting Orbital Debris Generation*, and *NASA Safety Standard (NSS) 1740.14, Guidelines and Assessment Procedures for Limiting Orbital Debris*.

The Aquarius project will provide the Aquarius instrument Orbital Debris Assessment (ODA) to the SAC-D project for the Observatory assessment. The SAC-D project will provide its Observatory ODA to the Aquarius project per the MOU (Article III, Item 14):

CONAE will use reasonable efforts to…provide NASA with the relevant pre-launch data, including mission requirements, design, constraints, analyses, safety, and operations information and any such additional equipment and documentation as may be required by NASA and agreed to in the Aquarius/SAC-D PIP.

If either the Aquarius Instrument or SAC-D Observatory assessments are non-compliant with NPD 8710.3B or NSS 1740.14, NASA and CONAE will work together to resolve the non-compliance or NASA will develop the appropriate waiver(s).

3.8 *Verification and Validation Planning*

3.8.1 AS Mission Verification and Validation Plan (AS-213-0196)

The *Aquarius/SAC-D Mission Verification and Validation Plan* specifies the overall processes and activities associated with verifying the Aquarius/SAC-D Observatory during all mission phases and at all levels of verification. It delineates the roles and responsibilities of each verification and validation organization associated with Aquarius/SAC-D. CONAE has overall mission V&V responsibility, but the associated tests and analyses will primarily be performed by their system contractor, INVAP.

3.8.2 AQ Project Verification and Validation Plan (AQ-213-0098)

The *Aquarius Project Verification and Validation Plan* describes the project-level plans for certifying the Aquarius Instrument's readiness for launch and provides appropriate V&V guidelines to the Aquarius Project Elements. The Aquarius PSET is responsible for verifying Level 1 and Level 2 functional and performance requirements have been satisfied. The document outlines the methods that the Aquarius Project will use to demonstrate that the Aquarius Instrument will be able to operate as an element of the

Aquarius / SAC-D Mission as designed. These activities will commence during system development and continue through post-launch checkout.

3.9 *AS Cooperative Monitoring Plan (AS-314-0015)*

Aquarius has a *Cooperative Monitoring Plan* with SAC-D that describes the technical cooperative approach to provide adequate and timely information for each partner, to update the technical progress of the development, and to assess any residual technical or schedule risk.

4 AQ Instrument Implementation Section

4.1 *Aquarius Instrument Description*

The Aquarius instrument includes an L-band microwave radiometer (1.413 GHz) and scatterometer (1.26 GHz). The radiometer will measure the surface brightness temperature, which is related to the surface emissivity and physical temperature of the seawater. The surface emissivity is determined by the dielectric constant of seawater, which is related to salinity. The scatterometer is required to provide coincident information of sea surface roughness, a critical correction term for retrieval of SSS. The salinity measurements will be averaged to reduce the impact of random errors. Independent calibration and validation approaches will be conducted to remove systematic errors related to uncertainty in absolute sensor calibration and possible long-term sensor drift.

The instrument consists of six functional parts: antenna, radiometers, scatterometer, command and data handling, mechanical and thermal, and power distribution. The figure below is a block diagram of the Aquarius instrument and its interfaces.

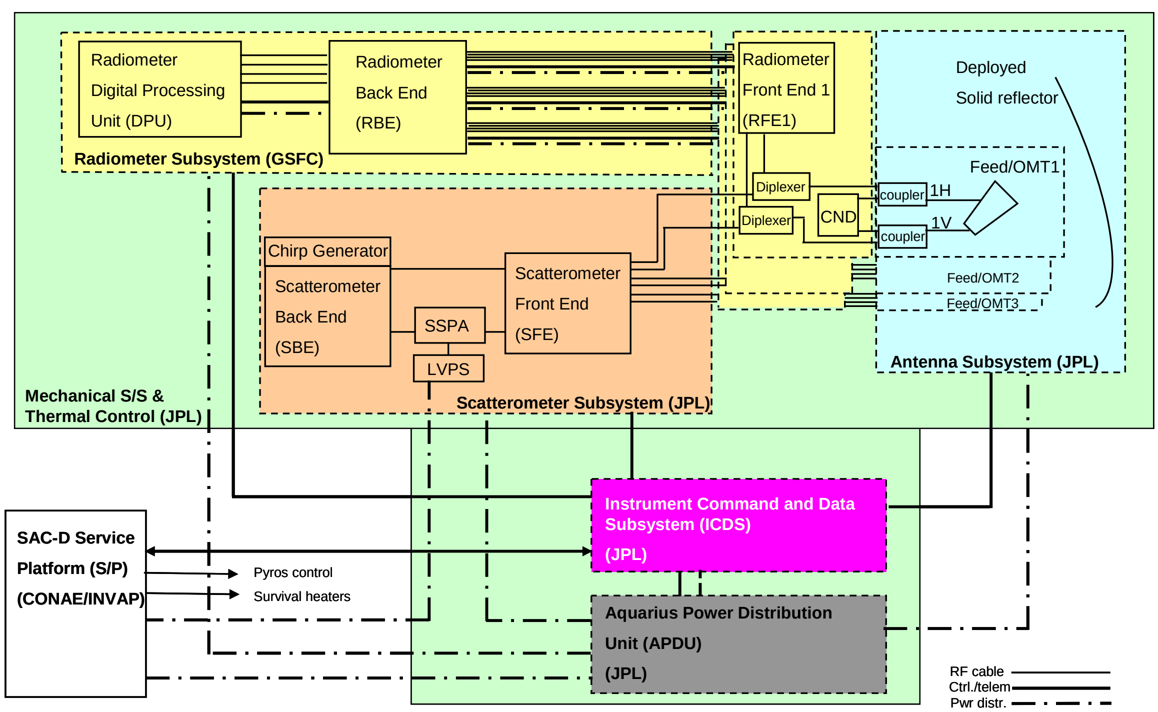

Figure 4.1-1 Aquarius Instrument Functional Block Diagram

The Aquarius instrument has a solid, offset parabolic reflector antenna with three beams to scan the ocean surface in 150km swaths which generates a global-repeat cycle every eight days. The 2.5-m reflector is deployed in two stages utilizing a constant rate spring and damper for each stage. The first stage releases the reflector following initiation of two separation nuts, and a pin-puller initiates the second stage to deploy the reflector boom. The Aquarius reflector and boom deployment sequence is shown in the figure below.

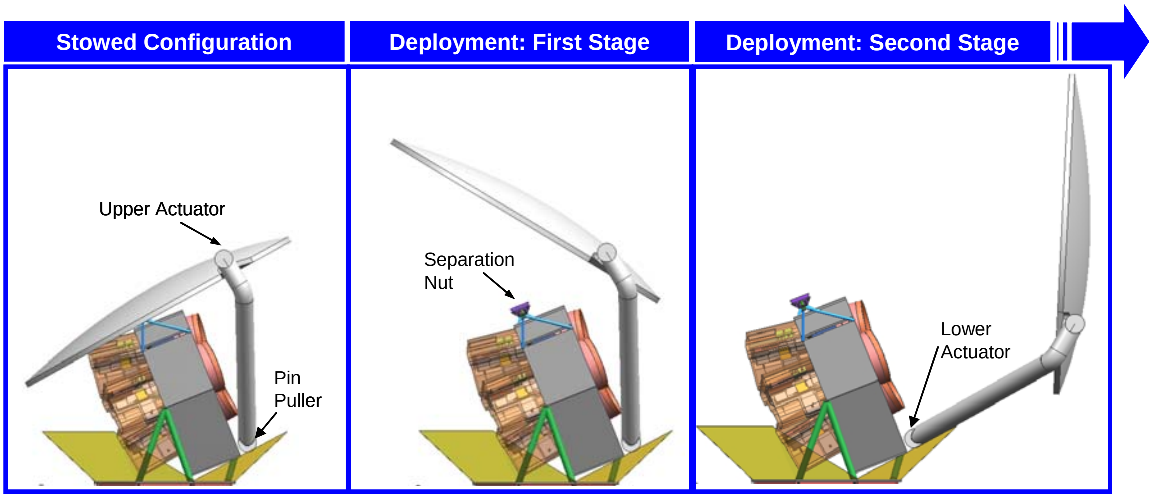

Figure 4.1-2 Aquarius Reflector and Boom Deployment

On each of the antenna feed horns is an L-band radiometer to measure the microwave emission from the ocean with a center frequency of 1413 MHz and a bandwidth of 27 MHz. A real-aperture L-band scatterometer shares the antenna with the radiometers to provide information to correct for the ocean surface roughness and transmits in the 1260MHz protected frequency. The radiometers (H, V, and ±45°) and scatterometer (co-polarization and cross-polarization) are polarimetric for correcting for Faraday rotation of the signals.

Near-simultaneous radiometer and scatterometer operation is achieved with a time-sharing design. The scatterometer transmits 1-ms pulses and sequentially scans through vertical and horizontal polarization channels on three antenna feed horns interleaved with intervals of received noise measurements (no transmitted pulse). Between the scatterometer transmit pulses, the radiometers sequence between antenna, Dicke and noise diode measurements. This timing scheme enables highly collocated radiometer and scatterometer observations. During this event, the ICDS will transmit a receive/protect message over the 1553 bus to the S/P Command and Data Handling Subsystem (C&DH) that envelopes the transmit event of the Aquarius radar. The C&DH is responsible for protecting the S/P and broadcasting the receive/protect warning to the remaining SAC-D instruments.

The key to high accuracy surface sea salinity retrieval from Aquarius instrument measurements is the thermal stability of the key instrument subsystems to 0.1 K. The latter is achieved by employing four ATC regions, one for each Ortho Mode Transducer (OMT) assembly/RFE radiators and one for the RBE/Scatterometer radiator. Each zone is independently controlled by Proportional Integral Derivative (PID) software. Post-launch, the absolute calibration bias will be corrected by a combination of on-orbit calibration sequences and by adjusting the coefficients of the retrieval algorithm.

To assure that the Aquarius/SAC-D Observatory provides sufficient resources for the accommodation of the Aquarius instrument, the Observatory technical resource requirements and the associated allocations for the Aquarius Instrument, CONAE and third-party instruments, and the Service Platform are documented in the *Level 2B Aquarius/SAC-D Mission System Requirements (AS-223-0101)*. The Aquarius project will assure that the Aquarius instrument resource allocation does not exceed the agreed upon resource allocation by tracking technical resources monthly, incorporating reviews as part of the design process, and, if necessary, implement appropriate descopes.

4.2 *Accountable Organization*

JPL will be responsible for the development, integration, testing and delivery of the Aquarius instrument for integration to the SAC-D S/P. The Aquarius instrument is primarily an in-house JPL developed instrument with the exception of the radiometer that is designed, built, integrated and tested by GSFC. Also, several key subsystem assemblies (i.e., the reflector, feed horn, and scatterometer electronic assemblies) will be subcontracted as discussed in Section 1.7.1.

The Aquarius instrument team will support the in-orbit operations through instrument checkout which is roughly launch plus 45 days. Following a successful PLAR, JPL will transition the lead center role to GSFC. The Aquarius instrument team (both at GSFC and at JPL) will be funded to support sustaining engineering, instrument anomaly assessment and resolution support. Sustaining engineering includes science algorithm development (e.g., scatterometer) and software modification (i.e., software patches).

4.3 *Design Process*

The design of the Aquarius instrument will be done concurrently using the Aquarius *Level 2A Aquarius Science Requirements*, *Level 2B Aquarius/SAC-D Mission System Requirements*, *Level 2B Aquarius/SAC-D Environmental Requirements*, and *Level 2B AQ/SAC-D Safety & Product Assurance Requirements* as the controlling documents for top-level requirements and constraints. Interfaces between the Aquarius instrument and the other Aquarius/SAC-D mission elements will be controlled by Interface Control Documents (ICD) as defined in the *Aquarius/SAC-D* SEIP.

The *Level 3 Aquarius Inst & Test Requirements (AQ-325-0112)* and all Level 4 instrument subsystem requirements are integrated into a central database for requirement tracking and flow-down, Dynamic Object Oriented Requirements System (DOORS), and will be reviewed by the Project System Engineering Team (PSET) to ensure that they are consistent with the higher-level requirements. The PSET also allocates, monitors, and controls the use of Project technical resources, including those of the instrument. A formal PMSR/SRR was conducted to ensure that the flow-down of all higher-level requirements (Level 2A and L2B) to the instrument system (key Level 3) are complete and accurate, and that they were sufficiently detailed to proceed into the preliminary design. Each instrument subsystem was required to hold a pre-PDR Subsystem Peer Review to ensure that the flow-down of the Level-3 instrument to the Level 4 instrument subsystems was complete, accurate and consistent with preliminary designs, such that the design was ready to proceed into Implementation. The results of the Peer Review findings was summarized and presented at the Project PDR. The Aquarius ECR process will first be used to control released documents and requirements. At the CDR, any changes in design and manufacturing will be tracked by the ECR process.

As specified in the *Aquarius Problem Failure Reporting Requirements/Procedure,* developmental Problem/Failure Reporting (PFR) system will be used for the testing of the brass-board and non-qualified engineering models at assembly level and up. A formal PFR system will be used for the proto-flight model integration and test. At the time of the proto-flight model manufacturing, developmental PFRs would be reviewed to see if any should become formal PFRs. The PFR system will be rated according to risk and closed according to the process outlined in the *Aquarius Problem Failure Reporting Requirements/Procedure*. A list of red flag and significant PFRs will be presented at MMRs and major mission-level reviews.

4.4 *Fabrication Process*

Following successful completion of the detailed instrument and subsystem design and the Project Critical Design Review, the instrument will proceed with the procurement and fabrication processes. Radiometer will begin fabrication following its successful subsystem design review. Since some instrument procurements may require longer lead times, the CDRs for those subsystems will take place sooner than the others.

4.5 *Aquarius Instrument I&T, Verification and Calibration*

The instrument flight hardware will undergo extensive testing at both subsystem and full-up instrument levels as outlined in the *Aquarius Instrument Integration and Test Plan (AQ-315-0142)*. Each subsystem will undergo performance and environmental testing to ensure that potential problems are identified at the lowest levels of assembly. Subsystem assembly-level testing will be performed at GSFC and JPL for their respective responsible elements.

After subsystem tests have been completed, the radiometer, scatterometer, antenna, avionics, and mechanical/thermal subsystems will be integrated and tested at JPL. The integrated Aquarius instrument will first undergo interface and functional testing. Subsequently, the instrument will undergo an environmental test program including acoustics, vibration, pyro-shock, thermal balance, thermal-vacuum (TV) including comprehensive performance, and EMI/EMC testing. EMI/EMC tests will assure that Aquarius will function properly within the EMI/EMC requirements. Pre- and post-dynamics tests will include a reflector deployment and alignment test.

Calibrations, functional and performance tests, and environmental qualification tests will be completed before instrument delivery to Argentina for Observatory Integration and Test consistent with the *Aquarius Instrument Verification and Calibration Plan (AQ-315-0110)*. Delivery of the instrument, along with all necessary ground system equipment and documentation, will be via air (logistics including transportation of equipment is discussed in Section 1.10.1).

4.6 *Aquarius Instrument Simulator*

The Aquarius team will develop an instrument simulator for use by the Service Platform to test interfaces with the S/P prior to Instrument-to-Service Platform integration and test. Similarly, the Service Platform will develop a S/P electrical simulator for use by the Aquarius Instrument, to test interfaces prior to instrument-to-S/P integration and test. The requirements for these simulators are defined in the *Aquarius Instrument to SAC-D Service Platform ICD (AS-335-0113)*.

Where applicable, Instrument mechanical models will be used to verify mechanical interfaces, the location of harness connectors, and to support pre-instrument delivery for mechanical integration testing.

4.7 *Aquarius Instrument Integration with SAC-D Observatory*

In the Aquarius/SAC-D Mission, the Assembly Test and Launch Operations (ATLO) activities typically begin with the Service Platform assembly and integration, referred to as Stage 1. Independent of the Service Platform, during Stage 1 the Aquarius instrument is being qualified as described in Section 4.5 above. Figure 4.7-1 shows the activities related to integration of the Aquarius Instrument and subsequent ATLO events and their location. The overall Observatory I&T program, described in the *SAC-D Observatory I&T Plan (SD-314-0137)*, is consistent with the *Aquarius/SAC-D Mission Verification and Validation Plan (SD-213-0196)*. Roles and responsibilities for logistics including transportation of equipment are discussed in Section 1.10.1.

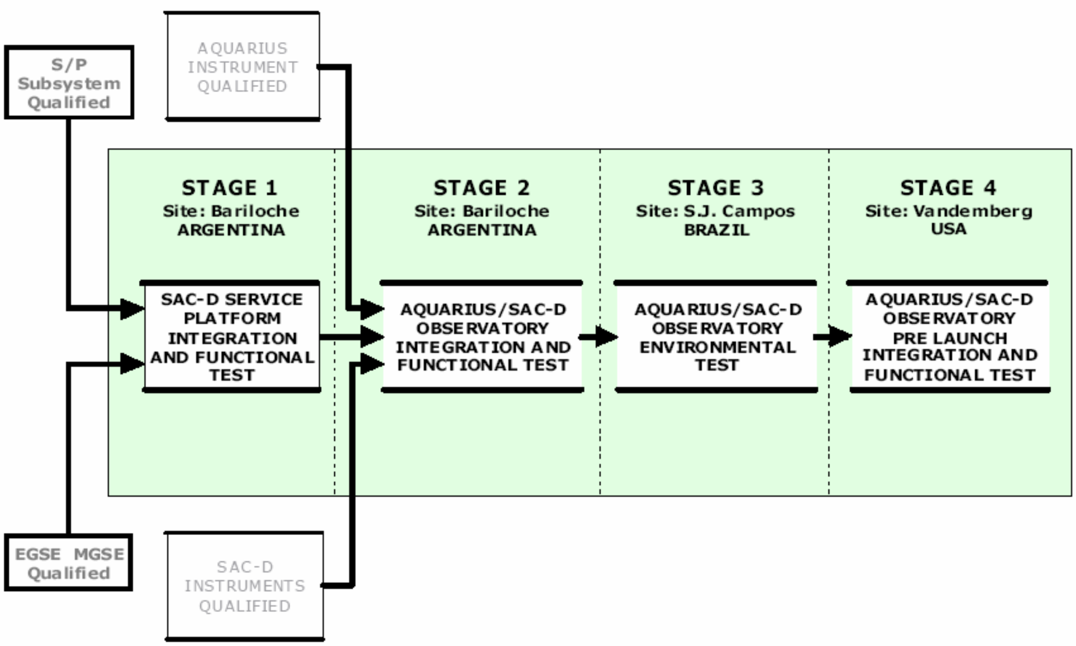

Figure 4.7-1 Aquarius/SAC-D Observatory I&T Stages

It is the responsibility of CONAE to integrate and test the Aquarius/SAC-D Observatory. CONAE subcontracts the Service Platform and Observatory I&T to INVAP as noted in Section 5.1. These facilities in Argentina have been the used in the development and testing of the SAC-A, B and C missions. For Aquarius/SAC-D, the existing facilities will require expansion to accommodate Observatory integration and functional testing. Aquarius will be the last instrument on the Observatory to be integrated by INVAP in Stage 2. Aquarius instrument acceptance tests and electrical Safe-to-Mate tests will precede mechanical and electrical I&T. Aquarius Functional & Limited Performance Tests will follow as specified in the *Aquarius Instrument Integration and Test Plan*.

Stage 3 of the Observatory I&T begins with a Post Shipment Test at Sao Jose dos Campos, Brazil. Similar to previous CONAE missions, CONAE subcontracts Instituto Nacional de Pesquisas Espaciáis (INPE) for environmental testing. The Aquarius instrument tests during the Observatory Environmental Test campaign include: EMI/EMC, thermal/vacuum, dynamic, mechanical, and separation tests.

At the launch site, the Aquarius project will participate in pre-launch integration and test activities including Functional Tests, End-to-End Mission Tests, Mission Sequence Tests, and Operations Readiness Tests.

5 SD Implementation Section

5.1 *SD Service Platform Implementation Section*

CONAE contracts the SAC-D Service Platform and Observatory Integration and Test implementation to INVAP. INVAP has documented their implementation plans and processes in the SAC-D Contractor PIP and *SAC-D Observatory Systems Engineering Implementation Plan (SD-314-0201)*. Key assemblies and parts are purchased by CONAE through subcontracts and provided to INVAP as government furnished equipment to eliminate customs taxes.

5.2 *SD Instrument Implementation Section*

The following instruments constitute the Argentine and third-party instrument providers of the Aquarius/SAC-D mission.

Organization	Instrument
CONAE	Microwave Radiometer (MWR)
CONAE	Near Infra- Red Sensor Technology (NIRST)
CONAE	High Sensitivity Camera (HSC)
CONAE	Data Collection System (DCS)
CONAE	Technological Demonstration Package (TDP)
ASI	Radio Occultation Sounder for Atmosphere (ROSA)
CNES	Influence of Space Radiation on Advanced Components/ Orbital System For Active Detection of Debris (CARMEN-1)

Table 5.2-1 SAC-D Payload

As specified in the NASA-CONAE MOU, CONAE is responsible for the design, fabrication, testing, calibration, and integration for launch of the SAC-D instruments consistent with the agreed upon schedules and key milestone dates specified Figure 1.3-2 and Table 1.3-1. CONAE is also responsible for the integration and test for launch any third-party provided instruments.

The NASA-CONAE MOU also specifies that any additional payloads follow a joint evaluation process prior to inclusion on the SAC-D Service Platform. Figure 5.2-1 shows the Aquarius/SAC-D instrument Selection Process that was developed and implemented during the Formulation Phase. The process was used to select the TDP instrument prior to final SAC-D payload selection (see Table 5.2-1 above) two months prior to Aquarius Project PMSR/SRR.

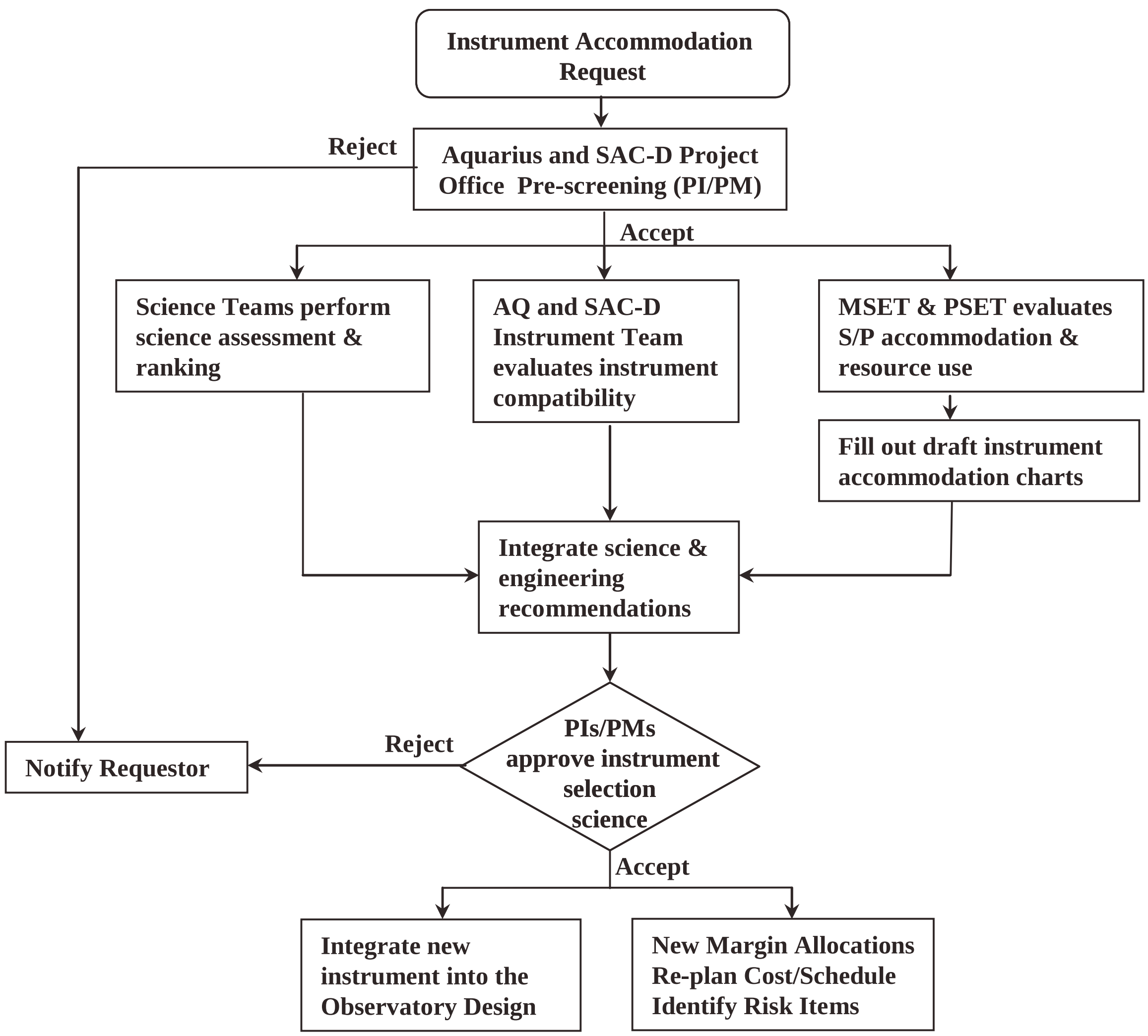

Figure 5.2-1 Aquarius/SAC-D Instrument Selection Process

The instruments and equipment listed in Table will be developed via contracts or agreements that will be part of the SAC-D project. For those instruments under CONAE development, in the event that a separate instrument project is required to carry out the activities related with the development/provision, this new project shall report to the SAC-D Project Manager. In any case, CONAE instruments shall be submitted to the whole set of Aquarius/SAC-D mission requirements, policies, and procedures.

In the event that the SAC-D payload exceeds the agreed upon resource allocation specified in the *Level 2B Aquarius/SAC-D Mission System Requirements (AS-223-0101)*, SAC-D will implement descopes identified in the *SAC-D Descope Plan (SD-212-5000)*.

6 Operations

6.1 *Ground System Implementation Section*

6.1.1 AQ Ground System Implementation Section

The Aquarius Ground System (GS) leverages existing data acquisition, production scheduling and archiving software developed for prior NASA Earth Science missions together with the operational experience of the GSFC SeaWiFS team and JPL PO.DAAC manager. The overall Aquarius GS development and management is the responsibility of GSFC. The Aquarius Ground System consists of three segments as shown in Figure 6.1-1.

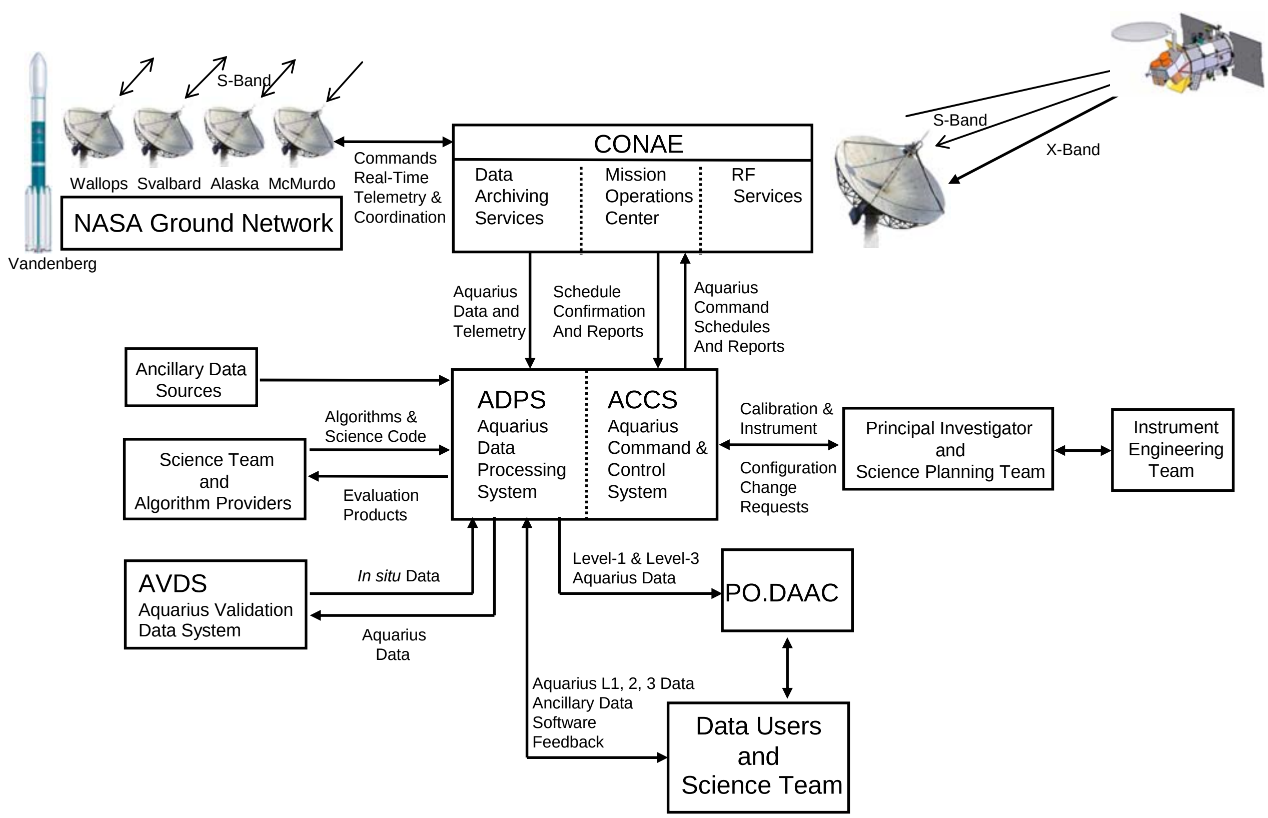

Figure 6.1-1 Aquarius Ground System and Interfaces

The ACCS is an expansion of the existing GSFC Ocean Data System that processes science data for several operational ocean-viewing projects. The ACCS provides Aquarius instrument command planning via the CONAE-provided Command Scheduler and scripting tools. The ACCS also performs Aquarius instrument monitoring via the CONAE-provided Telemetry Viewer and associated graphing tools. Aquarius commands are scheduled separately by the ACCS in accordance with science requests and with ground station contact times provided by CONAE. The ACCS generated commands are then merged into the Observatory command pass plan by the Command Schedulers at the CONAE MOC.

The ADPS is based on the GSFC's Oceans Data System which is presently supporting the SeaWiFS, Moderate Resolution Imaging Spectroradiometer (MODIS), Ocean Color Temperature Scanner (OCTS), and Coastal Zone Color Scanner (CZCS) programs and has been selected to support National Polar Orbiting Environmental Satellite System Preparatory Project (NPP) and GLORY. The ADPS retrieves Aquarius science data files captured from the AQ/SAC-D Observatory via the Data Archive and Distribution System (DADS) at the CONAE MOC. The ADPS then processes them to Level 3 science data products. The ADPS also archives and distributes files and products to both the JPL PO.DAAC and science users, including the Aquarius Science Team. To support data processing and data validation, the ADPS additionally retrieves and processes ancillary data and validation data from sources identified by the Aquarius Science Team.

The ACCS and ADPS are also integrated in-house GSFC elements of the Aquarius GS. In addition to retrieving science data from DADS, the ADPS also retrieves telemetry and auxiliary data and furnishes it to the ACCS via a CONAE-provided telemetry database structure that is compatible with the Telemetry Viewer. Likewise, commands and command scripts are stored on the ADPS in the CONAE-provided command database structure, compatible with the Command Scheduler.

The third segment of the Aquarius Ground System is the JPL PO.DAAC which archives level 1, 2, and 3 Aquarius data and distributes them to the scientific user community. The PO.DAAC is an existing in-house JPL facility which is an element of the Earth Observing System Data Information System (EOSDIS), and a member of the DAAC Alliance. The JPL PO.DAAC also distributes products from NASA's Earth Science Enterprise (ESE) Earth Observing System (EOS) project, as well as through partnerships and cooperative agreements with other organizations and institutes within and outside the United States.

The Aquarius Ground System interfaces with the CONAE MOC via e-mail, secure FTP, and via secure web protocols during standard operations. Restricted access e-mail servers support secure exchange of statuses, reports, and operational requests between the AQ GS Mission Operations team and the CONAE MOC Flight Operations team. The ACCS interfaces with the CONAE Observatory Command Scheduler via secure web protocol. It is also possible for the ACCS Telemetry Viewer to access real-time telemetry from the CONAE MOC Telemetry Server via secure web protocol. The ADPS utilizes secure FTP to retrieve files from DADS.

These interfaces will be tested formally during a Scheduled File Exchange Test and also during AQ/SAC-D End-to-End testing that is performed when the Observatory is configured for launch at Vandenberg Air Force Base. These tests are described in detail in the *Aquarius Ground System Integration, Test and Training Plan (AQ-336-0244)*.

6.1.2 SAC-D Ground System Implementation Section

SAC- D Ground System is based on the SAC-C Ground System which has been successfully operating SAC- C since its launch in December 2000. This system has also been used for SAC-B [launched in November 1996] and SAC-A [launched in December 1998].

Aquarius/SAC-D mission operations will be managed by the Mission Operations Center (MOC) in Córdoba, Argentina, otherwise known as Estacion Terrena Cordoba (ETC). The MOC is based on the SAC-C MOC and tailored for meeting Aquarius/ SAC-D mission requirements. The existing infrastructure at ETC is Argentina's main ground station facility for satellite commanding, telemetry and scientific data acquisition of CONAE and other space agency satellites.

Operations will follow the same philosophy used in the SAC-C mission. Slight modifications to the operations software are planned along with upgrades in the command and telemetry library and planning / scheduling tools.

All the activities described in the paragraphs above will be performed in house by CONAE, following the rules, practices and lesson learned from SAC-A, SAC-B and SAC-C projects.

In addition to ETC, NASA will provide additional ground station support during the Launch and Early Orbit (L&EO) Phase, propulsion maneuvers, and contingencies through the NASA Ground Network (NGN).

CONAE also plans to pursue additional ground stations within Argentina and/or third-party nations to enhance the Aquarius/SAC-D ground station coverage.

6.2 *Mission Operations Section*

Mission Operations will be conducted according to the *Aquarius/SAC-D Mission Plan (AS-213-0097)* that responds to the Aquarius and SAC-D Level 1 and Level 2A Science requirements.

6.2.1 AQ Mission Operations Plan (AQ-316-0157)

The Aquarius mission operations and processes will be captured in the Aquarius sections of the *Aquarius Mission Plan* and documented in the *Aquarius Mission Operations Plan*. This document includes the Instrument Operations Handbook, the Science Operations Handbook, the Aquarius Command and Telemetry Dictionaries and Flight Rules and Constraints, and all operational procedures (standard and contingency) including the anomaly resolution and close out process. It also includes the training manual for ACCS operation.

In addition, Aquarius has developed an agreement for ground station support from the NGN. The scope of the NGN activities to augment the Aquarius/SAC-D mission operations is outlined in the *Aquarius Project Service Level Agreement (AQ-241-0167)*.

Nominally, the Aquarius GS will be staffed to support operations during regular business hours, 8am to 5pm Eastern, and working days, Monday through Friday. The SAC-D MOC is operational around the clock.

6.2.2 SAC-D Mission Operations Section

CONAE has overall responsibility to conduct the Aquarius/SAC-D mission operations and provide for routine operational data products during the operational lifetime of the Aquarius and SAC-D instruments, as specified in the *Level 2B Aquarius/SAC-D Mission System Requirements (AS-223-0101).*

Aquarius and SAC-D will be required to archive science data and products generated from their respective payloads as defined in the *Aquarius Science Data Processing System Plan (AQ-316-0038)* and the *SAC-D Science Data Processing System Plan (SD-312-0058)*. Aquarius and SAC-D science data products will be exchanged between both projects as deemed necessary to ensure compatibility as stated in the *SAC-D Ground System to the Aquarius Ground System ICD (AS-336-0151b).* Any science data products obtained from the Aquarius/SAC-D mission will be archived by Aquarius and SAC-D for at least four years after completion of the Aquarius/SAC-D mission.

7 Education and Public Outreach Planning

7.1 *AQ Education and Public Outreach Plan (AQ 218-0127)*

The Aquarius EPO program will be implemented on contract by GSFC to Bigelow Laboratory for Ocean Sciences (BLOS). BLOS has developed an *Aquarius Education and Public Outreach Plan* that describes the goals, informal and formal education activities, and metrics by which the EPO program will be implemented.

7.2 *SD CONAE Education and Public Outreach Plan (SD-218-0047)*

The SAC-D Project has developed a *SAC-D Education and Public Outreach Plan* that describes how the SAC-D EPO program satisfies the Aquarius/SAC-D mission requirements and the Argentine National Space Program (2004-2015) guidelines.

8 Launch Service Implementation Planning

The Aquarius/SAC-D Observatory will obtain launch service from the NASA/Kennedy Space Center (KSC) Expendable Launch Services Office. The Launch Services include payload processing as well as the Launch Vehicle. The Observatory will be processed and launched from the Western Range at Vandenberg Air Force Base (VAFB), CA. The Aquarius/SAC-D Observatory will be integrated and launched on the Boeing Delta II 7320-10C. The launch services are provided by NASA/HQ ESSP Program Office. The technical and management implementation of the Aquarius/SAC-D Launch Services is captured in the *Aquarius/SAC-D Launch Services Implementation Plan* (LSIP) *(AS-211-0248)*. The key reviews that the project participates in during the launch campaign are captured in the following table.

Review	When (planned days before launch)	Purpose
Pre- Vehicle on Stand	L-60	Obtain concurrence to erect launch vehicle on pad, or to continue with launch vehicle processing at the field site
SC Mission Readiness Review (see major reviews)	L-44	Seek approval to continue mission processing towards the next milestone (FRR)
Launch Site Readiness Review (LSRR)	Approx: L-25 days	Establish that the launch vehicle and all launch site elements are ready for mating the SC to the launch vehicle
Flight Readiness Review (FRR)	L-3 to 5 days	Establish that the launch vehicle and all mission elements are ready for launch.
Launch Readiness Review (LRR)	L- 1 days	To verify the closing of all action items, verify vehicle, s/c and range status, weather briefing and Flight Certification signoff. Okay for S/Cs and launch vehicle to proceed with the terminal countdown.

Table 7.2-1 Planned Launch Reviews

The technical requirements for launching the Aquarius/SAC-D Observatory and injecting it into the agreed upon orbit is specified in the *Level 2B Aquarius/SAC-D Mission System Requirements (AS-223-0101).* In addition, the *Aquarius/SAC-D Launch Vehicle ICD (AS-233-0104)* will define the mechanical and electrical interfaces between the LV and the Aquarius/SAC-D Observatory. The ICD will also specify the LV and Observatory configurations, ground and flight environments, operational constraints/handling, and injection orbit parameters.

8.1 *Accountable Organization*

Aquarius/SAC-D is jointly implemented as a partnership mission under an international MOU, signed February 2, 2004. There is no lead agency. CONAE has the overall mission responsibility and end-of-life disposal responsibility. Both NASA and the JPL GPMC agree with this determination. JPL, being the NASA implementation center, will chair the PMC for MRR. At the MRR, joint participation by both agencies is needed to certify readiness to proceed for launch. The SAC-D PM will certify for launch readiness the Service Platform, SAC-D instruments including 3rd party instrument providers, Ground Station, and Mission Operations. The Aquarius PM will certify for launch readiness the Aquarius instrument, Aquarius Ground System, and the LV. Additionally, a general readiness summary will be provided by the NASA Program Manager at the MRR. Finally, the MRR board will determine the readiness to proceed.

9 Safety & Mission Assurance Implementation Planning

The Aquarius/SAC-D mission has jointly developed the Level 2B *Aquarius/SAC-D Safety and Product Assurance Requirements Document* (SPARD) which applies to Aquarius and SAC-D and their associated contractors. Each Partner has developed their individual Mission Assurance Plan (MAP) that defines the project-specific mission assurance program based on the joint requirements specified in the SPARD.

9.1 *AS System Safety Plan (AS-2110-0004)*

The *Aquarius/SAC-D System Safety Plan* is a joint document furnished as a basis from which Aquarius/SAC-D Management can generate safety requirements and plans to ensure safety of personnel and assets. The document specifies the pans to assure an acceptable level of safety through interface evaluations, risk control, and reporting methods acceptable to the Mission and its interfacing agencies. It will help to eliminate or control personnel injuries, equipment damage, and facility damage associated with Aquarius/SAC-D during its life cycle. The total safety activity will assure that an acceptable level of risk is achieved by the overall Project design and activities, and that the Aquarius/SAC-D Joint Management Team can certify that Aquarius/SAC-D Observatory is safe to launch.

9.2 *AS Mission Assurance Plan (AS-2110-0001)*

The *Aquarius/SAC-D Mission Assurance Plan* (MAP) defines the organization and the working of Aquarius/SAC-D Safety and Mission Assurance (SMA) Team, roles and responsibilities, requirements tailoring, SMA implementation and verification approach, and description of the mission assurance program.

9.2.1 AQ Mission Assurance Plan (AQ-2110-0130)

The *Aquarius Mission Assurance Plan* defines the JPL and JPL-contracted mission assurance program to be implemented in the development of the Aquarius Instrument in compliance with the MAP.

9.2.2 AQ Radiometer Product Assurance Plan (AQ-2110-0131)

The *Aquarius Radiometer Product Assurance Plan* defines the GSFC product assurance program to be implemented in the development of the Aquarius Radiometer in compliance with the MAP.

9.2.3 SD Mission Assurance Plan (SD-2110-0132)

The *SAC-D Mission Assurance Plan* defines the mission assurance program to be implemented in the development of the SAC-D Service Platform and Argentine Instruments in compliance with the MAP.

9.3 *SD Mission Operations Assurance Plan (SD-2110-0194)*

SAC-D Mission Operations Assurance Plan defines the SAC-D mission assurance program during operations in compliance with the MAP.

9.4 *AQ Mission Operation Assurance Plan (AQ-2110-0133)*

The *Aquarius Mission Operations Assurance Plan* defines the GSFC mission assurance program during operations in compliance with the MAP.

9.5 *Problem/Failure Reporting*

Each partner on the Aquarius/SAC-D mission will implement their own PFR system consistent with the PFR requirements included in the SPARD.

To ensure compliance with export control regulations, high-risk PFRs and PFRs affecting the Aquarius/SAC-D interfaces will be shared with the partner on a case-by-case basis. The exchanged PFRs will be independently reviewed by the partner including the implemented corrective action and the residual risk and risk rating.

9.5.1 Aquarius Problem/Failure Reporting

The Aquarius project will use a closed-loop, problem/failure reporting system. Both JPL and GSFC will comply with the PFR requirements.

The JPL automated database will be used to facilitate timely and orderly analysis, corrective action, risk assessment, and closure of the anomaly reports. GSFC will use its own problem reporting database. Both JPL and GSFC will have access to each other's database. All Aquarius-related PFRs written during I&T and ATLO will be captured in the JPL database. All Aquarius radiometer-related PFRs written during I&T and ATLO will be captured in both the JPL and GSFC databases. All reports, including those of suppliers, will be risk rated and Partners' reports will be integrated within the JPL system whenever appropriate.

All Aquarius PFRs written during Operations will be recorded in the GSFC database. In addition, all Aquarius PFRs related to JPL-developed hardware and software written during Operations will also be recorded in the JPL database.

9.5.1.1 Aquarius Problem Failure Reporting Requirements/Procedure (AQ-3510-0245)

Aquarius has written an *Aquarius Problem Failure Reporting Requirements/Procedure* that establishes the JPL and GSFC methodology for reporting, analysis, corrective action, review, and closure of problems and failures for the Aquarius Project in compliance with the SPARD.

9.5.1.2 Aquarius Flight Anomaly Reporting Procedures (AQ-2510-0007)

GSFC will develop and implement the *Aquarius Flight Anomaly Reporting Procedures* in compliance with the *Aquarius Problem Failure Reporting Requirements/Procedure*.

9.5.2 SAC-D Problem/Failure Reporting

CONAE has developed individual PFR closure procedures for the Implementation and the Operations Phase.

9.5.2.1 SAC-D Problem and Failure Reporting Plan (SD-324-0072)

The SAC-D PFR, analysis, and corrective action plan is applicable to all CONAE activity for the Aquarius / SAC-D Mission during development. This includes design, fabrication, integration and testing of all hardware, software, support equipment and associated software of the Service Platform and Argentine Instruments. Also, Observatory integration and testing activities shall also be covered by the contents of the *SAC-D Problem and Failure Reporting Plan.*

9.5.2.2 SAC-D Flight Anomaly Reporting Procedures (SD-2110-0194)

The SAC-D project will develop a *SAC-D Flight Anomaly Reporting Procedures* to define the processes and procedures that will be implemented during Operations.

10 Appendices

10.1 *Appendix A: Abbreviations and Acronyms*

The acronym list represents a subset of the official Aquarius/SAC-D Mission Acronym List and includes abbreviations and definitions only relevant to this document. The official Abbreviations and Acronyms can be found in APIC.

AA	Associate Administrator
ACCS	Aquarius Command and Control System
ADPS	Aquarius Data Processing System
AFT	Allowable Flight Temperature
AO	Announcement of Opportunity
APIC	Aquarius Project Information Center
APDU	Aquarius Power Distribution Unit
AQ	Aquarius
ARR	ATLO Readiness Review
AS	Aquarius/SAC-D
ASI	Agenzia Spaciale Italiana
ATC	Active Thermal Control
ATLO	Assembly, Test, & Launch Operations
AVDS	Aquarius Validation Data System
BLOS	Bigelow Laboratory for Ocean Sciences
C&DH	Command and Data Handling
CA	Cost Account
CAM	Cost Account Manager
CARMEN – 1	Influence of Space Radiation on Advance Components/Orbital System for Active Detection of Debris
CCB	Change Control Board
CDR	Critical Design Review
CM	Configuration Management
CONAE	Comisión Nacional de Actividades Espaciales
CNES	Centre National d'Etudes Spatiales
CPI	Cost Performance Index
CRR	Confirmation Readiness Review
CZCS	Coastal Zone Color Scanner
DADS	Data Archive and Distribution System
DC	Direct Current
DCS	Data Collection System
DP	Design, Verification/Validation, and Operations Principles for Flight Systems
DR	Discrepancy Reports
EAC	Estimate at Complete
ECR	Engineering Change Request
ECSS	European Cooperation for Space Standardization
EEE	Electrical, Electronic, and Electromechanical
EEPROM	Electrically Erasable Programmable Read-Only Memory
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOM	End-of-Mission
EOS	Earth Observing System
EOSDIS	Earth Observing System Data Information System
ESE	Earth Science Enterprise
ESSP	Earth System Science Pathfinder
ESR	Earth and Space Research
ESTD	Earth Science and Technology Directorate
ETC	Estimate to Complete
ETC	Estación Terrena Cordoba
EV	Earned Value
EVM	Earned Value Management
EVS	Earned Value System
FAR	Flight Anomaly Reports
FFP	Firm Fixed Price
FHLP	Flight Hardware Logistics Program
FMECA	Failure Modes and Effects Criticality Analysis
FPP	Flight Project Practices
FR	Failure Report
FRR	Flight Readiness Review
FFE	Friendly Front End
GHz	Gigahertz
GPMC	Governing Program Management Council
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
H/W	Hardware
HGA	High Gain Antenna
HK	Housekeeping
HKT	Housekeeping Telemetry
HSC	High Sensitivity Camera

HQ	Headquarters
HQA	Hardware Quality Assurance
I&T	Integration and Test
I&TRR	Integration and Test Readiness Review
IADC	Inter-Agency Space Debris Coordination Committee
ICD	Interface Control Document
ICDS	Instrument Command and Data Subsystem
IPPR	Institutional Parts Program Requirements
IRT	Independent Review Team
IM	Instrument Manager
IME	Information Management Engineer
INPE	Instituto Nacional de Pesquisas Espaciáis
INVAP	Investigaciones Aplicadas
ISA	Incident Surprise Anomalies
ISO	International Organization for Standardization
IV&V	Independent Validation and Verification
JPL	Jet Propulsion Laboratory
JSG	Joint Steering Group
KSC	Kennedy Space Center
L&EO	Launch and Early Orbit
LIT	Laboratorio de Integracao e Testes
LOA	Letter of Agreement
LRR	Launch Readiness Review
LSPO	Launch Services Planning Office
LSRR	Launch Site Readiness Review
LV	Launch Vehicle
LVEA	Launch Vehicle Environmental Assessment
LVIE	Launch Vehicle Integration Engineer
MA	Mission Assurance
MAM	Mission Assurance Manager
MAP	Mission Assurance Plan
MCDL	Master Controlled Document List
MCR	Mission Confirmation Review
MMR	Monthly Management Review
MOA	Memorandum of Agreement
MOC	Mission Operations Center
MODIS	Moderate Resolution Imaging Spectroradiometer
MOR	Mission Operations Review
MOU	Memorandum of Understanding
MRB	Material Review Board
MRR	Mission Readiness Review
MSE	Mission Systems Engineering
MSET	Mission Systems Engineering Team
MWR	Microwave Radiometer
MSR	Monthly Status Review
NASA	National Aeronautics and Space Administration
NGN	NASA Ground Network
NEPA	National Environmental Policy Act
NIAT	NASA Independent Advisory Team
NOA	Net Obligation Authority
NOAA	National Oceanic and Atmospheric Administration
NIRST	Near Infra-Red Sensor Technology
NPD	NASA Policy Directives
NPG	NASA Procedures & Guidelines
NPP	National Polar Orbiting Environmental Satellite System Preparatory Project
NSS	NASA Safety Standard
OCTS	Ocean Color Temperature Scanner
ODA	Orbital Debris Assessment
OME	Observatory Monitoring Engineer
OMT	Ortho Mode Transducer
ORR	Operational Readiness Review
PAF	Payload Attach Fitting
PEM	Project Element Manager
PER	Pre-Environment Review
PDR	Preliminary Design Review
PFR	Problem/Failure Report
PI	Principal Investigator
PID	Proportional Integral Derivative
PIP	Project Implementation Plan
PLAR	Post-Launch Acceptance/Assessment Review
PM	Project Manager
PMC	Program Management Council
PMSR	Preliminary Mission Systems Review
PO.DAAC	Physical Oceanography: Distributed Active Archive Center
POP	Program Operating Plan
PS	Project Scientist
PSE	Project System Engineer
PSET	Project System Engineering Team
PSLA	Project Service Level Agreement
PSR	Pre-Ship Review
PSU	Practical Salinity Unit
QSR	Quarterly Status Review
R&TD	Research and Technology Development
RBE	Radiometer Back End
Rec/Del	Receivables and Deliverables
RF	Radio Frequency

RFA	Request for Actions
RFE	Radiometer Front End
RME	Risk Management Engineer
RMS	Resource Management System
ROSA	Radio Occultation Sounder of Atmosphere
S/P	Service Platform
S/W	software
SAC-A, -B, -C, -D	Satélite de Aplicaciones Científicas, flight A, B, C, D
SCIT	Science Co-Investigator Team
SDR	Software Development Requirement
SEEA	Single Event Effect Analysis
SEIP	System Engineering Implementation Plan
SI	International System of Units
SMD	Science Mission Directorate
SMA	Safety and Mission Assurance
SMP	Software Management Plan
S/P	Service Platform
SPARD	Safety and Product Assurance Requirements Document
SQA	Software Quality Assurance
SRB	Standing Review Board
SFP	Standard Flight Project
SPI	Schedule Performance Index
SRB	Standing Review Board
SWBS	Standard Work Breakdown Structure
SRR	System Requirements Review
SSS	Sea Surface Salinity
SV	Schedule Variance
TAA	Technical Assistant Agreement
TDP	Technology Demonstration Package
TV	Thermal Vacuum
UPN	Unique Project Number
USAF	United States Air Force
VAFB	Vandenberg Air Force Base
V&V	Verification and Validation
WA	Work Agreement
WBS	Work Breakdown Structure
WR	Western Range

10.2 *Appendix B: Non-Compliance Matrices*

10.2.1 Aquarius Non-Compliance Matrices

The complete Aquarius Flight Projects Practices Compliance Matrix (AS-283-0094) and Aquarius Design Principles Compliance Matrix (AS-283-0094a) are maintained in the Aquarius project library. The Aquarius project variances to the Flight Project Practices and Design Principles are listed below in Table 10.2-1 and Table 10.2-2 respectively.

Table 10.2-1 Aquarius Flight Project Practices (Rev. 2) Non-Compliance Matrix

FPP Section	Flight Project Practice	Rationale/Comments	Residual Risk & Mitigations
5.2.2.1	Project implementation planning is based on the JPL standard product-oriented Work Breakdown Structure (WBS). (See Section 5.5)	The Aquarius WBS was established in Phase A, prior to release of the JPL Standard WBS. The development of the Aquarius WBS was motivated by project partnerships, roles, and responsibilities.	Low Risk; Mitigation: Aquarius identified and mapped variances from the JPL SWBS to the Aquarius WBS, including the associated definitions, to demonstrate that all the JPL SWBS functions were accounted for. The information was reviewed and approved by the Cost Office Manager.
5.3.2.1	The PS is: Collocated with the project manager and the project office staff with the expectation that the majority of his/her time will be spent in the project office.	JPL PS not co-located with Project Office due to facility constraints.	Low Risk; Mitigation: JPL PS accessible to project office personnel, including cell phone. Project Scientist also engaged in weekly staff, weekly quiet hours, science meetings, and any ad hoc meetings.
5.3.2.2	Fully supported by project funds with the expectation that up to half of his/her time may be used for project-related research activities, or that an equivalent level of funding from the project will be available to support research activities by a post-doc or junior colleague. The details of such an arrangement are negotiated as part of the Science Office Management Plan.	Funds to support Project Scientist consistent w/ partnership agreements and available Aquarius science budget. Project Scientist is funded at half-time level to support project-level work. The remainder of his time spent on research is not paid for by the project.	Low Risk; Mitigation: PS research activities funded by external sources and JPL internal Research and Technology Development (R&TD) program throughout the life of the Aquarius mission.

FPP Section	Flight Project Practice	Rationale/Comments	Residual Risk & Mitigations
5.3.5.1	Staffing, job descriptions, funding levels, and reporting paths for scientists involved in the project, including both those who work with the PS directly and those who work as investigation scientists. The expectation should be that all such investigation scientists, and other science support persons such as experiment reps or instrument reps, report to the PS or his/her designee.	Establishment of Aquarius project roles and responsibilities specifies that GSFC manages overall science activities. JPL PS coordinates with JPL scientist and reports to the PI (at ESR) & Deputy PI (at GSFC).	Low Risk; Mitigation: Project has outlined clear lines of authority for PI, Deputy PI, and PS for managing science activities and has documented the roles and responsibilities in the Science Management Plan.
5.4.1	Competed (PI-led) projects build their pre-launch organizations around the structure depicted in Figure 5.4-1.	Aquarius multi-center interfaces and international partnerships drive the pre-launch organizational structure. Organization tailored to suit mission partnership and highlight roles and responsibilities.	Low Risk; Mitigation: Roles & responsibilities are specified in PIP and system implementation plans.
5.5.2	The project develops a final WBS and accompanying dictionary prior to the preliminary design review (PDR) for Phases C-D and E. The project uses the Standard Flight Project WBS Template and the WBS Tailoring Guidelines. Deviations from the tailoring guidelines require concurrence by the Project Costing Office. The project extends the WBS and dictionary using the WBS Tailoring Guidelines to the level necessary to implement and verify the work (typically WBS Level 4 or 5).	Same rationale as 5.2.2.1	Low Risk; Mitigation: Project utilized the SWBS dictionary as a template to implement and verify the work to Level 4 or 5. All applicable products, processes, and functions listed in the SWBS captured in the project dictionary. The information was reviewed and approved by the Cost Office Manager.
6.5.1	Projects use the JPL Launch Services Planning Office (LSPO) during the formulation phase to plan and initiate acquisition of launch services. As the project transitions to the implementation phase (or at an earlier time agreed to between the LSPO and project), the LSPO hands the launch service acquisition activities over to the project's launch vehicle integration engineer (LVIE).	LV interfaces and logistics established early by System Engineer on the project with Service Platform insight and experience with spacecraft to launch vehicle interfaces. The LVIE, resident at GSFC, is responsible for planning, initiating, and coordinating acquisition of launch services on the Aquarius project with KSC and NASA/HQ.	Low Risk; Mitigation: Function performed by an individual within the project that has LVIE experience with other NASA Earth-orbiting missions, including coordinating with KSC.

FPP Section	Flight Project Practice	Rationale/Comments	Residual Risk & Mitigations
7.1.4	Each project develops and releases the following additional mission-assurance related plans. Preliminary versions of these plans are available prior to the PMSR. Final versions are approved by both the project manager and the manager of the Mission Assurance prior to PDR: Reliability Engineering; Quality Assurance; Electronic Parts Program Requirements; Problem Reporting; Systems Safety.	1) Problem Reporting Procedure will not be released until CDR, which is non-compliant with principle 2) The EEE parts, H/W QA, S/W QA, Rel assurance, problem reporting requirements are documented in Aquarius/SAC-D Safety and Product Assurance Requirement Document (SPARD) which will be released following MCR. Level 1 requirements are only signed/released by HQ at MCR. Assessments to changes, if any, will be evaluated and flowed down to subsequent requirements. 3) Safety Plan has been released for PDR.	Low Risk; Mitigation: 1) Problem Reporting requirements established in Safety and Product Assurance Requirement Document (SPARD), which is released after MCR. Preliminary Problem Reporting Procedures available prior to protoflight hardware being built; final plan released before CDR. 2) SPARD currently ready to be signed, but awaiting final approval of Level 1 requirements.

Table 10.2-2 Aquarius Design Principles (Rev. 5) Non-Compliance Matrix

DP Section	Design Principles	Rationale/Comments	Residual Risk & Mitigations
4.1.3.1	**Single failure tolerance/redundancy** -- No credible single failure of any electrical, mechanical or electromechanical element shall result in loss of the minimum mission.	Aquarius is essentially a single-string instrument, but has some redundancy (e.g., 1553, RS-422, and pyro initiators) and graceful degradation (e.g., 3 radiometer/feed horn) included in design.	Medium Risk; Mitigation: short 12 month minimum mission, grade 2 parts program, DP margins, and single-string electronic assemblies accumulate 1000hrs of operation prior to launch. Reliability and parts analysis will be performed to demonstrate minimum mission goal can be satisfied.
4.9.1.2	**Protection for credible single faults** -- Fault protection software shall be specified in the systems engineering process to handle all credible flight system single-fault scenarios.	Aquarius instrument is essentially a single-string instrument and there will be numerous single faults that cannot be handled by fault protection software.	Low Risk; Mitigation: Fault tree analysis and subsystem testing will be performed to satisfy 12 month minimum mission success. Instrument will autonomously safe and await ground command following a fault.
4.10.2.1	**Local single point ground** -- Each subsystem ground tree (i.e. power converter secondary) shall have a local single point DC ground to spacecraft chassis via the shortest practical wire length.	Aquarius radiometer, RF system requires a multi-point ground system to minimize noise.	Low Risk; Mitigation: Following NASA-HDBK-4001, standard approach for RF circuits and utilizing JPL EMC and Grounding experts in outlining grounding architecture with GSFC Radiometer team.

DP Section	Design Principles	Rationale/Comments	Residual Risk & Mitigations
4.11.4.11	**Protection against incorrect memory use** -- Software shall be designed to protect against incorrect use of memory: a. Execution in data areas, unused areas, and other areas not intended for execution. b. Unintended over writing of code areas.	Heritage hardware, RAD6000, does not preclude incorrect memory use in data areas not intended for execution.	Low Risk; Mitigation: Satisfy software reliability requirements through verification effort as specified in the SMP. System functional and environmental tests will be performed. ICDS can also reboot and load software from redundant EEPROM.
4.12.4.1	**Power converter synchronization** -- Subsystem power converters shall be capable of operating via an externally supplied synch frequency signal or in a free-running mode, near the synch frequency.	Aquarius instrument is sensitive to noise. Instead of filtering out a synch frequency, Aquarius keeping noise levels low across the instrument (see mitigation).	Low Risk; Mitigation: Architecture of the APDU (Faraday cage, common mode filtering) minimizes radiated noise such that output ripple levels are not higher without the sync. Output ripple is also minimized in the target boxes (radiometer, Scatterometer) by using linear regulators. EMI tests will confirm overall Observatory and Aquarius radiated noise levels.
4.12.6.3	**Payload/Instrument electronics design temperature range** -- Except for detectors, optics, and other instrument-unique hardware, the payload instrument electronics shall be designed to the spacecraft bus electronics requirements.	Aquarius instrument allowable flight temperatures (-5°C to + 40°C) and operational design temperatures (-20°C to +60°C) are compliant with Qual temperature range (-15/+20°C) but not limits (-35/+75°C).	Low Risk; Mitigation: Aquarius instrument AFT or design limits tailored for project and will encompass adequate margins (-15/+20°C) required for our polar, Earth-orbiting mission. Thermal analysis, subsystem qualification test, and system thermal vacuum test will confirm instrument design and instrument interfaces (i.e., Service Platform) satisfy all nominal operational scenarios.
4.12.6.5	**Design temperature range for spacecraft mechanisms** -- Spacecraft mechanisms shall be designed for –35 degrees C to + 75 degrees C or AFT temperature limits extended by –15 degrees C and +20 degrees C, whichever is greater.	Aquarius instrument deployment mechanism (spring and damper) allowable flight temperatures (+10°C to +25°C) and operational design temperatures (-5°C to +45°C) are compliant with Qual temperature range (-15/+20°C) but not limits (-35/+75°C).	Low Risk; Mitigation: Aquarius mechanisms operated only once during the mission, occurs within first couple of months after launch. Design will include deployment heaters on damper to operate mechanism within AFT. Thermal analysis and subsystem qualification test will confirm design satisfies deployment scenario and survives all nominal operational scenarios over the full temperature limit (-5/+45°C).
6.3.6.1	**Power distribution circuit margin at key project life cycle milestones** -- At implementation phase start (phase C/D), there shall be 30 percent margin on the spare power switch and circuit count, including cabling and connector pins to accommodate late identified needs with minimum cost, schedule impact.	Service Platform is providing the main power distribution circuits and complies with the 30% spare switch margin. The Aquarius PDU (APDU) provides dedicated power to the Aquarius instrument and does not have spare switches or circuits.	Low Risk; Mitigation: APDU has 30% DC/DC converter power margin and 30% connector pin margin at PDR. APDU board utilization allows for additional switches and circuits.

10.2.2 SAC-D Non-Compliance Matrices

SAC-D is not required to comply with the JPL FPP (revision 5) and DP (revision 2), but the project has voluntarily assessed the Project's compliance with the JPL guidelines. The compliance assessment performed by CONAE and INVAP of the FPP reveals that SAC-D does not have any FPP non-compliances. SAC-D does have DP non-compliances which are documented below.

Table 10.2-3 SAC-D Design Principles (Rev. 5) Non-Compliance Matrix

DP Section	Design Principles	Rationale/Comments	Residual Risk & Mitigations
4.3.1.1	**Power system grounding/fault tolerance** -- The prime power distribution hot and return lines shall be DC-isolated from spacecraft chassis by at least 2 K ohms.	Heritage from SAC-C, that had a direct connection of the power return to chassis.	Analysis is being done, from the Power and EMI/EMC perspective, to change the current strategy to meet this principle.
4.3.2.1	**Load removal** -- Prime power on/off switching of electrical loads shall be done by "simultaneously" switching both hot and return sides.	Current design implements a solid state switch only for hot side.	
4.3.2.3	**Load shedding architecture** -- A critical and non-critical prime power bus shall be considered.	Even though the SAC-D will not implement two separated power buses, the design meet the intent because the loads are considered with two separated supplies strategies: some loads are no-switched and other are switched loads.	
4.8.2.5	**Design margin under anomalous conditions** -- For non-credible, but plausible, conditions the thermal design shall maintain temperatures within AFT limits extended by -15°C, and + 20°C (i.e. qual/protoflight levels)	Not possible to comply unless conditions are specified.	

DP Section	Design Principles	Rationale/Comments	Residual Risk & Mitigations
4.10.2.1	**Local single point ground** -- Each subsystem ground tree (i.e. power converter secondary) shall have a local single point DC ground to spacecraft chassis via the shortest practical wire length.	It is considered that SAC-D partially complies because the SAC-D grounding philosophy: a bleed resistor is attached to chassis that is large enough that it has no practical electrical effect on the circuit, but it permits any stray charge to "bleed" to ground. Decrease the currents on ground loops. Improve the DC/DC converters operation.	
4.12.1.4	**Sensor use in autonomous control loops** -- Sensors used to signal a condition to be managed via on-board autonomous control shall be reliable, or else inadvertent activation shall be shown by analysis to have benign consequences. Unreliable sensors e.g. micro-switches shall be avoided in such applications.	Delta imposes the use of micro-switches to detect S/P-LV separation.	S/P uses micro-switches in a 2 of 3 voting logic.
4.12.6.2	**Bus electronics design temperature range** -- Bus electronics (at the mounting or thermal control surface for the specified assembly) shall be designed for –35 degrees C to + 75 degrees C or AFT temperature limits extended by –15 degrees C and +20 degrees C, whichever is greater.	SAC-D will use AFT -15deg and +20deg. Partially compliant. Same rationale as Aquarius.	
6.3.4.1	**Energy margin at key project life cycle milestones** -- At implementation phase start (phase C/D), the design shall have 40% or more energy margin (depending on new or inherited hardware/designs) assuming an allowable depth-of-discharge of 40% and current best estimate (CBE) of electrical load demand, including losses.	Seems too conservative if applied to the Observatory nominal operation during eclipse (worst case) for 40% battery DoD, including contingency for loads consumption growths as required in the REL (20 to 30% for CBEs at this stage). Margin over margin?	

DP Section	Design Principles	Rationale/Comments	Residual Risk & Mitigations
6.3.5.1	**Flight software margins at key project life cycle milestones** -- A development shall observe the following experience-based guidelines for margin at critical development milestones: a. At computer selection: 75% Margin; b. At implementation start (start of Phase C/D):60% Margin; c. At launch: 20% Margin	SAC-D is compliant with this principle for the new designs. Exception is C&DH software, which has heritage from SAC-C.	
7.1.2	**Critical Sequence Telemetry Monitoring** -- Mission critical event (e.g., Launch Vehicle separation, deployments, etc.) and deployables verification shall be available via real-time telemetry.	Solar array deployment will be performed and should be performed right after separation from the Launch Vehicle, and that will not happen in RF visibility.	Having the solar panels deployed is the more reliable configuration for the spacecraft after separation from the launch vehicle The memorandum of understanding which is being worked-out with the Italian Space Agency foresees the use of the Malindi Ground Station for real time tracking of the Solar Panels deployment

10.3 *Appendix C: Aquarius Descopes*

Descope Options	Hardware Impact	Cost Savings	Impact	Meets Level 1 Science Baseline	Meets Level 1 Science Minimum
Remove Radiometer polarimetric capabilities (+45 and -45 channels)	Fewer channels, fewer front-end components	~$0.6M (MCR) ~$0.2M (CDR))	Loss of Faraday rotation correction; large systematic errors	No	Yes
Reduce number of feeds from 3 to 2	Eliminates one feed, fewer electronics	~$0.5M (MCR) ~$0.3M (CDR)	33% data loss per month. Reliability risk: reduced graceful degradation	No	Yes
Reduce Observatory monitoring	None	~$1M (CDR)	Reduced visibility into SAC-D development	N/A	N/A
Eliminate Scatterometer	Complexity, mass, power, workforce	~$7.7M (MCR) ~$4M (CDR)	No direct roughness correction; increase largest error source	No	Yes
Eliminate Active Thermal Control (ATC)	Reduced hardware & ICDS scope	~$1M (MCR) ~$0.2M (CDR)	Reduced radiometer calibration stability	No	Yes
Reduce mission from 3 years to 2 or 1 year	None	~$5M/yr in Ops	No interannual climate variations. Insufficient seasonal cycle statistics for 1 year.	No	Yes

10.4 *Appendix D: Aquarius Project Cost*

Obligation	Risk Mitigation	Phase B		Phase C/D				Phase E				
WBS Description	Phase	FY04	FY05	FY06	FY07	FY08	FY09	FY09	FY10	FY11	FY12	Total
01 Project Management	591	1,166	1,812	1,514	1,609	1,667	844	-	-	-	-	**9,201**
JPL	559	810	1,263	1,514	1,609	1,667	844	-	-	-	-	8,265
GSFC	32	356	548	-	-	-	-	-	-	-	-	936
02 Science	393	506	837	2,194	2,716	3,044	1,652	-	-	-	-	**11,341**
JPL	92	151	239	332	574	873	504	-	-	-	-	2,765
GSFC	301	355	598	1,862	2,143	2,171	1,147	-	-	-	-	8,577
03 System Engineering	320	628	1,218	1,128	1,051	1,040	690	-	-	-	-	**6,074**
JPL	320	628	1,057	1,128	1,051	1,040	690	-	-	-	-	5,913
GSFC	-	-	162	-	-	-	-	-	-	-	-	162
04 Observatory	102	755	316	580	691	808	639	-	-	-	-	**3,891**
JPL	-	-	-	580	691	808	639	-	-	-	-	2,718
GSFC	102	755	316	-	-	-	-	-	-	-	-	1,173
05 Instrument	713	1,936	12,004	30,783	20,362	6,729	1,952	-	-	-	-	**74,480**
JPL	713	1,652	9,819	23,161	15,642	5,769	1,505	-	-	-	-	58,261
GSFC	-	285	2,125	7,615	4,692	961	448	-	-	-	-	16,124
Other NASA Centers	-	-	60	7	28	-	-	-	-	-	-	95
06 Ground System	-	215	321	923	1,567	2,164	1,418	-	-	-	-	**6,607**
JPL	-	5	16	26	24	114	-	-	-	-	-	185
GSFC	-	209	305	897	1,543	2,050	1,418	-	-	-	-	6,422
07 Operations	-	-	-	-	-	-	-	3,079	5,254	4,304	2,371	**15,008**
JPL	-	-	-	-	-	-	-	837	1,079	675	514	3,106
GSFC	-	-	-	-	-	-	-	2,242	4,175	3,628	1,856	11,902
08 Education/Outreach	-	48	45	127	169	151	132	-	-	-	-	**671**
JPL	-	-	3	6	34	15	15	-	-	-	-	72
GSFC	-	48	42	121	135	136	117	-	-	-	-	599
10 Mission Assurance	24	300	1,048	2,811	2,078	978	292	-	-	-	-	**7,531**
JPL	24	192	729	2,811	2,078	978	292	-	-	-	-	7,104
GSFC*	-	108	319	-	-	-	-	-	-	-	-	427
Subtotal	**2,143**	**5,553**	**17,601**	**40,058**	**30,243**	**16,580**	**7,619**	**3,079**	**5,254**	**4,304**	**2,371**	**134,805**
09 Launch System (KSC Bypass)	-	-	1,300	1,245	36,199	27,035	9,871	-	-	-	-	**75,650**
Subtotal All Centers	**2,143**	**5,553**	**18,901**	**41,303**	**66,442**	**43,615**	**17,490**	**3,079**	**5,254**	**4,304**	**2,371**	**210,455**
	-	-	-	-	-	-	-	-	-	-	-	**-**
Reserves	-	-	-	9,911	7,457	6,928	3,286	490	788	645	357	**29,860**
Cum Reserves % by Phase				30%	32%	42%	43%	15%	15%	15%	15%	**-**
	-	-	-	-	-	-	-	-	-	-	-	**-**
Other NASA Cost	22	75	165	511	318	200	67	26	14	6	1	**1,405**
Carry Out	-	2,364	1,939	5,468	1,872	1,289	-	1,018	863	525	-	**15,338**
Carry In	-	-	(2,364)	(1,939)	(5,468)	(1,872)	(1,289)	-	(1,018)	(863)	(525)	**(15,338)**
Total Mission Funding Requirements	**2,165**	**7,992**	**18,641**	**55,254**	**70,621**	**50,160**	**19,553**	**4,613**	**5,902**	**4,616**	**2,203**	**241,721**

*GSFC MA for Phase C/D carried in WBS 05 and in WBS 07 for Phase E

10.5 *Appendix E: Aquarius Project Workforce*

JPL Workforce	Risk Mitigation Phase	Phase B		Phase C/D				Phase E			
WBS Description		FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Total
01 Project Management	2.5	3.4	4.7	4.5	4.5	4.5	2.3	-	-	-	**26.4**
02 Science	0.4	0.5	0.8	1.1	1.9	2.9	1.6	-	-	-	**9.2**
03 System Engineering	1.5	2.5	4.4	3.6	3.1	3.7	2.3	-	-	-	**21.1**
04 Observatory	-	-	-	1.8	2.0	2.2	1.7	-	-	-	**7.7**
05 Instrument	3.1	6.0	31.2	48.6	36.2	16.1	5.0	-	-	-	**146.2**
06 Ground System	-	0.0	0.1	0.1	0.1	0.4	-	-	-	-	**0.7**
07 Operations	-	-	-	-	-	-	2.5	3.3	2.0	2.1	**9.9**
08 Education/Outreach	-	-	-	-	-	-	-	-	-	-	**-**
10 Mission Assurance	0.1	0.5	1.1	1.3	1.3	1.3	0.8	-	-	-	**6.5**
Total JPL Workforce	**7.6**	**12.9**	**42.4**	**61.0**	**49.0**	**31.1**	**16.2**	**3.3**	**2.0**	**2.1**	**227.6**

Table 10.5-1 JPL Workforce by Phase

GSFC Workforce	Risk Mitigation Phase	Phase B		Phase C/D				Phase E			
WBS Description		FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Total
01 Project Management	-	0.4	2.7	-	-	-	-	-	-	-	**3.1**
02 Science	-	0.4	1.7	3.3	3.9	3.9	2.2	-	-	-	**15.4**
03 System Engineering	-	-	0.5	-	-	-	-	-	-	-	**0.5**
04 Observatory	-	0.6	0.9	-	-	-	-	-	-	-	**1.5**
05 Instrument	-	1.2	8.5	18.6	16.5	3.3	1.6	-	-	-	**51.1**
06 Ground System	-	0.1	1.1	2.6	5.5	7.2	4.8	-	-	-	**21.2**
07 Operations	-	-	-	-	-	-	5.6	9.5	7.3	3.6	**26.0**
08 Education/Outreach	-	-	-	-	-	-	-	-	-	-	**-**
10 Mission Assurance	-	-	1.4	-	-	-	-	-	-	-	**1.4**
Total GSFC Workforce	**-**	**2.7**	**16.7**	**24.5**	**25.8**	**14.4**	**14.2**	**9.5**	**7.3**	**3.6**	**118.8**

Table 10.5-2 GSFC Workforce by Phase*

*GSFC MA for Phase C/D carried in WBS 05 and in WBS 07 for Phase E

10.6 *Appendix F: Aquarius WBS Dictionary*

The Aquarius WBS (Level 1 to 3) is shown in Figure 1.3-1. Below is the detailed WBS Dictionary to the cost account level for Phase C/D/E.

Element Number	Element Name	Element Manager	Element Description
01	Management	Amit Sen	The business and administrative planning, organizing, directing, coordinating, controlling, and approval actions designated to accomplish overall Aquarius Project objectives which are not associated with specific hardware or software elements.
01.01	JPL Project Office	Amit Sen	WBS Roll-up
01.01.01	Project Management	Amit Sen	Project Management is solely responsible for the business and administrative planning, organizing, directing, coordinating, controlling, and approval actions designated to accomplish overall ESSP-Aquarius project objectives. Includes other Project Office support personnel. Costs for some document services and shipping.
01.01.02	Project Office Support	Amit Sen	Funds business and resource control activities for the Project. Includes business planning, maintenance of the Project schedule, financial control, production of cost estimates, and operation of the Project performance measurement and reporting systems. Personnel include the Project Business Manager, the Project Resource Administrator (PRA), and the Project Schedule Analyst (PSA).
01.01.03	Travel	Amit Sen	Manage all International travel for JPL support only.
01.01.04	Reviews	Amit Sen	Provide support for major internal reviews of the Project, such as SR/CR, PDR, CDR and Pre-Ship, and subsequent RFA preparation and Board report.
01.02	GSFC Project Office	Scott Greatorex	WBS Roll-up
01.02.01	Project Management	Scott Greatorex	Project Management is solely responsible for the business and administrative planning, organizing, directing, coordinating, controlling, and approval actions designated to accomplish overall ESSP-Aquarius project objectives which are not associated with specific hardware or software elements until Launch + 30 days. Phase 5 Project Management responsibilities transferred to GSFC (WBS 7.1)
01.02.02	Project Office Support	Scott Greatorex	Provide support to the project and Project Manager.
02.0	Science	Gary Lagerloef	The technical and management efforts of directing and controlling the Science investigation aspects of the Project through development, including Launch +45 days. Includes, for example: the efforts associated with defining the science requirements; ensuring the integration of the science requirements with the Aquarius Instrument, CONAE Payloads, and SAC-D; providing the algorithms and software for science data processing and analyses; science simulator. Excludes: hardware and software of on-board science investigative Instruments / Payloads.
02.01	PI & ESR Science	Gary Lagerloef	WBS Roll-up
02.01.01	Management & Administrative support	Gary Lagerloef	The Principal Investigator (PI) is responsible for the performance of all requirements of this contract, the oversight of the science team established by separate contracts or agreements with NASA, and identification to NASA of all actions necessary to ensure success concerning all aspects of the mission including instrument and Spacecraft definition, development, integration and test; ground system operations, science operation, mission operations and data acquisition and distribution.
02.01.02	Aquarius Validation Data Segment (AVDS)	Gary Lagerloef	The Aquarius validation measurements will include all applicable oceanographic data to be routinely collected from various sources and assembled in the AVDS at ESR. AVDS will develop an Interface Control Document with Aquarius Data Processing Segment (ADPS).
02.01.03	ESR Research	Gary Lagerloef	1) The development and production of a merged analysis of Aquarius satellite and in situ Level 3 data product. 2) The pre-launch scientific analyses of AVDS data sets, produce coarse gridded fields, and analyze large scale hydrologic balances over the ocean, and publication of the results in the scientific literature.
02.02	GSFC Science	David LeVine	WBS Roll-up
02.02.01	DPI Management	David LeVine	Deputy PI and pre-launch science at Goddard. This includes all the roles and responsibilities of the Aquarius DPI and also includes support for his research and management of ocean science and remote sensing science work at GSFC (e.g. support for activities in WBS 2.2.2, 2.2.3, 2.4 and 2.5 below). It also includes supervision of development of the science Cal/Val plan. The costs include salary, travel and miscellaneous expenses associated with research (e.g. computer support and publication costs).

Element Number	Element Name	Element Manager	Element Description
02.02.02	GSFC Ocean Science	David LeVine	WBS Roll-up
02.02.02.01	GSFC Ocean Science	David LeVine	Pre-launch science studies by GSFC scientists, on-site contractors and members of the Science Team; a) Develop, document, and verify the surface density algorithm and its error to provide gridded field. b) Develop, document and test mixed layer models to link SSS and SST with subsurface profiles from ARGO profiling float data for science and validation. c) Funds as needed for GSFC Co-I's such as S. Hakkinnen. d) Funds for non-NASA science team members.
02.02.03	GSFC Remote Sensing Science (Radiometer)	David LeVine	WBS Roll-up
02.02.03.01	GSFC Remote Sensing Science (Radiometer)	David LeVine	Pre-launch research on the radiometer retrieval algorithm, including effects of roughness and the correction for geophysical parameters that effect propagation (e.g. Faraday rotation). a. Includes refinement of the Aquarius radiometer retrieval error table. b. Includes effects of sun-glint and land-water boundaries c. Development of a simulation tool with which to test retrieval algorithms.
02.03	JPL Science	Yi Chao	WBS Roll-up
02.03.01	Project Scientist Activities	Yi Chao	Provide the science support to the Aquarius Project Office at JPL, Science requirements development, Support various project level reviews, Provide interface between the JPL Aquarius project office and the Aquarius science team and the PI.
02.03.02	JPL Ocean Science	Yi Chao	WBS Roll-up
02.03.02.01	JPL Ocean Science	Yi Chao	Conduct salinity and hydrological cycle investigations in support of Aquarius
02.03.03	Remote Sensing Science (Scatterometer)	Simon Yueh	WBS Roll-up
02.03.03.01	Remote Sensing Science (Scatterometer)	Simon Yueh	*No activity*
02.04	Level 1, 2 & 3 Algorithms	David LeVine	WBS Roll-up
02.04.01	Radiometer (GSFC)	David LeVine	Develop Level 1, 2, and 3 algorithms along with a data simulation system. The algorithms will be documented and tested. The algorithms will be provided to the Aquarius Science Data Center, where they will be coded in final form. Deliverables: Level 1, 2, and 3 algorithms, algorithm documentation and verification data, end to end simulation of data through put and error analysis.
02.04.01.01	Radiometer (GSFC)	David LeVine	Contractor support for Remote Sensing Systems to provide, with assistance from the Aquarius team, the following products. a. L1B: Provide the Aquarius Science Data Center with algorithms necessary to convert instrument telemetry quantities into calibrated values of brightness temperature (TB) at the sensor at TOA in swath coordinates. b. L2A: Provide the Aquarius Science Data Center with algorithms necessary to convert calibrated values of brightness temperature at the sensor (TOA, L1 product) into geo-located values of TB at the earth surface in swath coordinates. Identify sources of needed ancillary data. Add flags as necessary (e.g. for rain). c. L2B: Provide the Aquarius Science Data Center with algorithms to convert calibrated, roughness corrected brightness temperature at the surface (L2B) into SSS. This includes a roughness correction provided by the scatterometer, and corrections for antenna pattern and ground contamination. Data in swath coordinates.
02.04.02	Scatterometer and L2B Roughness Correction (JPL)	Simon Yueh	WBS Roll-up
02.04.02.01	Scatterometer and L2B Roughness Correction (JPL)	Simon Yueh	a. Ground System Algorithm Development: Provide ground system with radar calibration algorithms necessary for converting instrument telemetry quantities into earth located sigma–0 values; b. Cal/Val Analysis Tool Development: Develop algorithms and software to perform postlaunch Cal/Val, including functionality, health and safety checks, radar performance.
02.05	Science/Calibration & Validation	David LeVine	WBS Roll-up: Develop a calibration plan for the Aquarius instrument. This includes a plan for on-orbit calibration and post launch validation; and includes research on calibration techniques and issues specific to Aquarius. A plan for pre-launch testing of the instrument components (radiometer, scatterometer, antenna) to insure that they work together to meet the measurement requirements will provided by an instrument WBS but coordinated for science purposes here.
02.05.01	Cal/Val Plan	David LeVine	This includes includes a plan for on-orbit calibration and post launch validation. The plan for pre-launch testing of the instrument components (radiometer, scatterometer, antenna) needed to develop calibration will provided by an instrument WBS but coordinated for science calibration purposes here. Support (cost) for the DPI activities are covered in WBS2.2.1.
02.05.02	Surface Drifter SSS Measurements (ESR)	David LeVine	No Activity
02.05.03	Calibration and Validation Research	David LeVine	Contractor support for research at the University of Michigan. The work includes research on antenna issues associated with calibration and research on novel post launch calibration and validation techniques such as vicarious calibration.

Element Number	Element Name	Element Manager	Element Description
03.0	Project System Engineering	David Durham	The technical and management efforts of directing and controlling an integrated engineering effort for the Project. Includes: the effort to define the Project space-ground system; the integrated planning and control of the technical program efforts of design engineering, specialty engineering, fabrication engineering, and integrated test planning; the effort to transform operational Project objectives into a description of system requirements and a preferred system configuration; the technical oversight and control effort for planning, monitoring measuring, evaluating, directing, and replanning the management of the technical program. Documentation Products include: Mission/System Requirements Document (MSRD); Interface Control Documents (ICDs); Risk Management Plan; and Verification and Validation (V&V) Plan. Excludes: any design engineering cost.
03.01	Project System Engineering	David Durham	WBS Roll-up
03.01.01	Project System Engineering Staff	David Durham	Leads the Projects overall system architecture, definition and engineering functions. Provides for the Project System Engineer and staff. Includes, management of project requirements and flow down, development of project verification matrix; defining and managing inter-system interfaces, coordination of PSE products between the Projects external partners (GSFC & CONAE), the PI, and Science Teams; acts as Project Risk Engineer coordinating efforts associated with the projects risk list; implements the project"s margin policy and manages Project technical resources; and defines fault protection and mission fault tree. Runs the Project System Engineering Team and manages the Project Action-Item List, RFA Closure Process and provides engineering support for working ECRs. Provide resources for engineering system and subsystem discipline engineering support required for assessment of Project-level technical issues and staff to provide support and insight into instrument and observatory technical trades, issues and problems. Complete and maintain SE documentation products include: System Engineering Reports, Mission System Requirements Documents, Resources and Equipment List System Functional Block Diagram and Schematics, System Description Documents, ICDs, Project Review Plan, Mission/System Fault Trees, Review Agendas; Review Reports. Project Risk Management Plan, Significant Risk List; metrics on risk items, Systems Engineering Implementation Plan, Technical Resource Management Plan. This work will be implemented consistent with the following procedures: Project System Engineering-- Phase A, Rev. 0 (http://rules.jpl.nasa.gov/cgi/doc-gw.pl?DocRevID=100231 Project System Engineering-- Phase B, Rev. 0. (http://rules.jpl.nasa.gov/cgi/doc-gw.pl?DocRevID=100334)
03.01.02	Project SW Engineering	David Durham	Support Aquarius instrument, ground system and test software architecture effort, and establish a S/W Management plan. Includes: development of SW policies & practices; defining software requirements; SW design; SW implementation; SW test issues; flight/ground tradeoffs; as required. Coordinate Aquarius software with that of SAC-D and ensure compatible interfaces and capabilities. Develop Aquarius Software Management Plan and Software Risk List.
03.02	Mission Design, Orbit Analysis & LAE	Gerry Hintz	WBS Roll-up
03.02.01	Mission Design	Gerry Hintz	Lead effort for establishing the Aquarius mission planning and execution consistent with the developed operations concept, requirements and designs that are necessary to meet the Aquarius science objectives and support the integration of the Aquarius/SAC-D mission plan and sequences. Co-chair a joint NASA/CONAE mission planning working meeting to develop the mission sequences and plans and to obtain insight in the integrated Aquarius/SAC-D mission design and risks consistent with the instrument and Ground system capabilities. Includes, for example: developing Aquarius planning and operational guidelines and constraints for the mission; supporting NGN ground station requirements and interface definition. This support will extend to include pro-active review and assessment of the mission risk associated with the opeational strategies and capabilities developed by SAC-D. Provide for Aquarius participation and inputs to Aquairus/SAC-D Mission design reviews, to include CDR, Operations Readiness Review, Mission Readiness Review. Provide Aquarius support for End-to-End Information System (EEIS) Engineering for the Aquarius Science and telemetry data streams. Includes, for exampl data flow and resolution of issues concerning instrument data flow from Observatory to the end users. Provide on an as needed basis additional orbit analysis, requested by the Science Team or the Mission System Engineering Team, to reassess or clarify orbit requirements. Support Science by generating various views or graphical representation of the orbit, footprint of the 3-beam antenna on the Earth track, as requested. The main products are: inputs into the joint the Mission Plan, Aquarius/SAC-D Ground Systems ICD; Data System Design Documents, EEIS Data Flow Document and Instrument contingency plans.

Element Number	Element Name	Element Manager	Element Description
03.02.02	Orbit Analysis & Design	David Durham	Assess the Aquarius science requirements with respect to compatible orbits; derive orbit requirements; and perform orbit designs and analysis. Analysis should utilize Earth orbit determining software; result in orbit requirements and graphical depictions of candidate and recommended orbit designs; developing Earth-relative departure targets for the launch vehicle; evaluating utilization of the launch period; developing the end-to-end baseline orbit design; and derived orbit requirements. Results of the study are to be coordinated with the SAC-D orbit analysis to establish a mutually acceptable set of orbit requirements, designs and orbit maintenance strategy that satisfies both Aquarius and SAC-D mission objectives. Products to include an Aquarius Orbit Trade Study White Paper, inputs to the Mission System Requirement Document and the Aquarius/SAC-D Orbit Specification and Maintenance Document .
03.03	Info System Engineering Com & Configuration Management	Bob Vincent	WBS Roll-up
03.03.01	Info Mgmt/Config Mgmt	Bob Vincent	Information Management WA Text Statement of Work (General areas of support: All Phases) Objective is to ensure the effective capture, configuration control, and dissemination of information that is generated or required by Project members during the Project lifecycle. Ensure assigned project complies with Institutional IM policies, processes, and procedures (e.g., Manage Project Information and Information Technology Process, ISO 9001, NGP 7120.5A, ITAR, JPL/NASA IT Security, FPP) - Develop and implement project-specific procedures to meet the project information sharing and collaboration needs through the projects lifecycle - Design, implement, manage, and maintain a project information management system (PIMS) for the capture, management, and archiving of controlled documents and records and uncontrolled working files - Provide project-specific specifications and interface with project tool providers to set up Action Item Tracking System, Project Portal/Web, Email archive, and other IM tools - Develop and implement project data access control and information sharing policies, guidelines (including any ITAR/EAR, proprietary, discreet specs) for collaboration with internal and external project users - Provide internal and external user access to project IM tools and project product data files, as per established Institutional and project access control policies - Co-author the Information Management components of the assigned Project Information, IT, and Configuration Management Plan and pr - Provide IM support for Project Reviews - Interface with JPL IM system providers and Project Partners IM/IT staffs to facilitate collaboration and provide training and first-level IM/IT support to project internal and external users.
03.04	Launch Vehicle Interface Eng	Shin Huh	WBS Roll-up
03.04.01	Launch Vehicle Interface Eng	Shin Huh	1. DESCRIPTION OF WORK PACKAGE RESPONSIBILITIES AND APPROACH/ACTIVITIES -Develop Aquarius/SAC-D interface inputs (Questionaire)with SAC-D representatives and facilitate the the development of the Launch Vehicle ICD with KSC and the LV Provider -Maintain and manage the Launch Vehicle Interface Requirements document (JPL) -Provide Aquarius and SAC-D inputs to the Launch Site Support Plan 2. Cochair with NASA/KSC the Systems Integration Working Group and support the following technical interface disciplines: Structural/Mechanical, Thermal/Environmental, Flight/Mission Design, Flight and Ground/Launch Operations 3. Assure that the necessary technical support is provided by JPL/GSFC (Aq GS)/CONAE and INVAP (SAC-D GS and Observatory) to establish and resolve functional, physical, mission and project peculiar requirements on the launch vehicle and assure the timely resolution of integration and interface action items, design solutions and problems. 4. Assure that integration/interface analyses and tests are satisfactorily supported and ensure that the spacecraft design will meet the launch vehicle system launch profile and environments. 5. Assure that the necessary documentation to support integration and interface activities is provided and maintained. 6. Facilitate the delivery of the Aquarius/SAC-D LV related deliverables to NASA/KSC as defined below. 7. Serve as the Projects point of contact to NASA/KSC ELV office and Boeing launch services regarding launch vehicle integration matters representing both NASA and CONAE''s interests. 8. Support the following Project and Launch Vehicle System Reviews: - NASA Focus Aquarius Mission CDR and CONAE Focus SAC-D CDR - Launch Site Readiness Review - Pre - (Launch) Vehicle on Stand Review - SAC-D Ground Operations Review - Center (KSC) Director Launch Vehicle Launch Readiness Review - Aquarius/SAC-D Flight Readiness Review - Aquarius/SAC-D Launch Readiness Review 9. Specific WORK PACKAGE INPUTS/OUTPUTS are defined in the Aquarius schedule and Rec/Del list define the specific launch vehicle engineering related receivables and deliverables per the NASA/KSC NLS contract for the Aquarius/SAC-D Mission.

Element Number	Element Name	Element Manager	Element Description
03.05	Project V & V	Dave Durham	WBS Roll-up
03.05.01	Project V & V	Dave Durham	This position is the Aquarius Verification and Validation (V&V) engineer reporting to the Project System Engineer (PSE). The Project V&V responsibilities and associated tasks involve inter-system V&V testing and auditing of lower level system/subsystem testing. The majority of the tasks involve testing activities between the instrument, observatory, and ground system (both the CONAE ground system and the Aquarius ground system at Goddard (GSFC). Major tasks are defined below.
04.0	Observatory Support	Scott Greatorex	The entire Flight hardware that includes the spacecraft, a platform for carrying payload, instruments and other mission-oriented equipment in space to the mission destination(s) to achieve the mission objectives. Also includes all design, development, production, assembly, and test efforts to deliver the completed Flight System/Spacecraft for integration with the launch vehicle.
04.01	Observatory Insight	Amit Sen	WBS Roll-up
04.01.01	Observatory Insight	Amit Sen	Management of and support for the Observatory development to Launch + 30 days.
04.01.02	SAC-D Service Platform I&T Support	Amit Sen	Lead the business and resource control processes for the GSFC portion of the Aquarius project. Office will interface with WBS 1.2. Includes, for example: all Project resource planning and control activities; maintenance of the Project schedule; financial control; production of cost estimates; operation of the Project performance measurements and reporting system(s). Personnel include: Finance; Planning / Scheduling personnel.
05.0	Instrument	Simon Collins	The equipment provided for special purposes in addition to the normal equipment integral to the spacecraft. Includes, for example: experimental and scientific data gathering equipment placed on board the flight system.
05.01	Instrument Management	Simon Collins	WBS Roll-up
05.01.01	Instrument Management	Simon Collins	Manage and coordinate instrument design and implementation activities. Oversee overall instrument design, supervise development of flight hardware/software, monitor and coordinate payload I&T and post-launch instrument checkout activities, and identify and manage instrument risk items and cost. Provide leadership for and manage instrument development through Post-Launch Assessment Review (L+45). Function as the primary interface between the Instrument and the Project. Also includes regular interaction with the PI and his/her team.
05.01.02	Domestic Travel	Simon Collins	This cost account manages all funding for domestic travel by the JPL instrument team.
05.01.03	Reviews	Simon Collins	Provide review support to peer-level instrument reviews at JPL. Support for Project-level reviews is provided by the Project Office.
05.02	System Engineering	Dalia Mcwatters	WBS Roll-up
05.02.01	System Engineering	Dalia Mcwatters	The Instrument system engineering task leads overall instrument design to ensure that the instrument meets its functional and performance requirements and integrates successfully with the spacecraft. The task includes developing, configuration controlling and tracking the instrument performance requirements, instrument power and mass, instrument electrical , mechanical, and thermal interfaces (both internal to the instrument and external to the Service Platform, testing equipment, etc.). The task includes tracking performance and test requirement flow down to level 4 and 5 specs, and developing instrument test plans and reviewing procedures. Instrument system engineering provides engineering support to ATLO, V&V, and pre and post-launch calibration, and monitors qualification during thermal/vacuum testing. In addition, the task includes supporting the Aquarius reviews and conducting action-item follow-up, as well as establishing and maintaining activity implementation plans, schedules and cost plans, and managing the performance of the work against these plans as documented in the approved work agreements.
05.03	Electronics	Mimi Paller	WBS Roll-up
05.03.01	Instrument Command & Data Subsystem	Mimi Paller	Closed and re-opened 05.05.03.xx. (Design, build, and test: instrument electronics power supply/conditioning; processor; memory; data storage; data collection; Analog-to-Digital (A to D) conversion; telemetry collection).
05.03.02	Power Subsystem	Mimi Paller	Cloaed and re-oened 05.03.04.xx. (Provide regulated DC power using DC/DC converters to the radiometer and Analog Electronics Unit electronics, scatterometer, and ICDS)
05.03.03	ICDS	Mimi Paller	WBS Roll-up
05.03.03.01	ICDS Engineering	Mimi Paller	Manage and coordinate ICDS activities
05.03.03.02	Hardware Engineering	Mimi Paller	ICDS BreadBoard and Flight Model design, fab, and test. The Hardare Eng account..includes workforce and breadboard parts
05.03.03.03	BCE	Mimi Paller	ICDS Bench Checkout Equip design, fab, and test. The BCE account includes hardware, software, breadboard cables and simulators
05.03.03.04	Parts	Mimi Paller	Includes only Flight Model parts
05.03.03.05	Packaging	Charles Kaczinski	Flight Model Packaging, fabrication and assembly
05.03.03.06	Flight Software	Mimi Paller	Flight Software Engoneering

Element Number	Element Name	Element Manager	Element Description
05.03.04	APDU	Charlene Lortz	WBS Roll-up
05.03.04.01	APDU Engineering	Charlene Lortz	Responsible for APDU system engineering, management and requirement documentations tasks
05.03.04.02	Hardware Engineering	Charlene Lortz	Responsible for APDU designs for BB and FM 2. Long lead parts selection for FM 3. Identify FM electrical parts. 4. Generate test plans and test procedures 5. Responsible for APDU analyses 6. Verify interfaces between APDU and other subsystems 7. Prepare CDR and HRCR See attached schedule for tasks details
05.03.04.03	BCE	Charlene Lortz	Summary of tasks for this period: 1) BCE management includes CDR support 2) BCE detail design 3) BCE fabrication and assembly 4) BCE integration and test See attached schedule for task details, receivables and deliverables with due dates
05.03.04.04	Parts	Charlene Lortz	Procurement of all APDU FM electrical parts except for DC/DC converters and filters procured in Phase B.
05.03.04.05	Packaging	Charlene Lortz	Perform Electronic Packaging Engineering for the Aquarius APDU subsystem. This task includes packaging engineering, design, analysis, fabrication and assembly as detailed in Section 10 of the WA.
05.04	Antenna	Joe Vacchione	WBS Roll-up
05.04.01	HGA Assembly	Joe Vacchione	This Work Package is responsible for the overall High Gain Antenna Assembly effort including Completion of antenna analyses, test planning, and Antenna assembly testing. It also includes support for antenna assembly programmatic planning, project interface, and design reviews. The workforce for this effort is described below: The work of the antenna team is divided among the following team members as described below: Cog Engineer: -Responsible for overseeing entire antenna task -Provides interface with project and other Aquarius instrument personnel -Supports all project meetings and reviews -Supports project cost exercises -Reports schedule progress and provides inputs for MMRs. -Responsible for Antenna Assembly Requirement documents, test plans, performance reports -Responsible for Antenna Assembly PDR -Performs some antenna assembly analyses and makes recommendations to project regarding antenna design changes which may benefit the overall Aquarius Instrument performance Antenna Assembly Analyst: -Performs detailed analysis of the antenna assembly -Provides predictions of antenna / spacecraft interactions -Studies and evaluates potential new antenna This DOES NOT include the effects of possible sun shades or other methods for controlling antenna patterns in the solar side-lobe region - this activity will be covered in the 05.04.04 work package. -Performs reflector sensitivity analyses including reflector position tolerances, reflector shape tolerances, effects of feed support & reflector support structures, and any other items that effect performance. -Works with system engineers and mechanical structures engineers to assess the major areas of concern. Antenna Test Engineer: -Develops the preliminary testing approach for Antenna Assembly RF testing -Supports Cog Eng during test plan development
05.04.02	Reflector	Joe Vacchione	This WBS provides for the costs associated with the antenna assemblie's reflector contract only - CTM activity covered by Mechanical Work Package -not included here
05.04.03	Feeds/OMT	Joe Vacchione	This Work package provides funding for the Aq feeds and includes Completion of detailed design of Feeds, validation of design using one (1)full scale engineering model, fabrication of three (3) FM feeds, and RF & thermal validation of feeds at JPL. Note: Feed CTM Task carried out by Antenna Cog Eng in the 05.04.01 account
05.05	Mechanical Subsystems	Denise Hollert	WBS Roll-up
05.05.01	Mechanical Subsystems	Denise Hollert	Provide for the leadership and management functions for the mechanical work element of the Aquarius Instrument as defined in work agreements 102394.05.05.02-.08. It is responsible for the overall technical performance, schedule and resource management for the mechanical element. This work agreement also includes mechanical systems, lead design, material and fastener engineering. It provides the development of all mechanical external interfaces, the alignment budget and verification plan, Instrument mass/mass properties, Aquarius Configuration Layout,top level assembly/installation drawings, M&P Plan and MIUL review. Lastly this work agreement provided LOE mechanical engineering support to I&T.
05.05.02	Loads/Dyn/Stress	Brian Childs	Provide loads, stress and dynamics support for the design of the Aquarius Instrument for phase C/D.
05.05.03	Antenna Support	Bernardo Lopez	Provide for mechanical support for the design of the antenna assembly components, comprised of one reflector and three feeds, including Contract Technical Management (CTM) of the reflector contract, and design, fabrication and delivery of other components associated with the feeds, as described in the Objectives and Products Section. This work agreement also provides for the development of the feed configuration layout.
05.05.04	Instrument Structure	Alexander Erremenko	Provide for the development, design, fabrication and delivery of the Aquarius Instrument Mechanical Structure and Sun Shade
05.05.05	Mechanisms	Joel Johnson	Provide for the detailed design, fabrication/procurement, assembly, test, and delivery to Instrument Integration & Test of the Aquarius Mechanisms and Separations hardware, which includes the Launch Restraint and Separation Joints, the Upper and Lower Deployment Mechanisms, and the Boom Assembly.

Element Number	Element Name	Element Manager	Element Description
05.05.06	AHSE	Pim Vosse	Provide for the Phase C/D development, design, fabrication and delivery of the Mechanical Ground Support Equipment (MGSE) for the Aquarius Project. The Aquarius MGSE deliverables are defined in section 10 of this Work Agreement.
05.05.07	Cabling	John Tallon	1. Development of a cabling block diagram representing the cabling provided or installed under this WA and system interfaces. 2. Provide engineering support for electrical interfaces to all experiment subsystems 3. Cable design and documentation for all cables fabricated under this WA. The cable design shall be consistent with mockup fabrication techniques. 4. Procurement of cable fabrication materials (connectors, wire, etc.) 5. Fabrication, test, and on-site delivery of deliverables listed below. 6. Installation drawing for all delivered cable assemblies. 7. Connector bulkhead, bracket, and cable tray design support.
05.05.08	Thermal Engineering	Patrick Wu	Develop, implement, verify, validate, and deliver the Aquarius Instrument Thermal Control System. This includes the thermal design, hardware implementation, testing, delivery of subsystem hardware, and the ATC hardware and software.
05.06	Scatterometer	James Bowen	WBS Roll-up
05.06.01	Scatterometer Engineering	James Bowen	Responsible to design, develop, and fabricate the scatterometer subsystem for the Aquarius instrument. The subsystem will be an L-band polarimetric scatterometer that will correct for sea surface roughness. This work package will also support programmatic efforts, project interface, and design reviews. This affort is divided into the following work packages: 1) Scatterometer Cog E Management, which is responsible for: a) overseeing the entire scatterometer task b) supporting project meetings and reviews c) supporting project cost exercises d) reporting schedule progress and providing inputs for MMR e) development of level 4 requirements f) development of EICDs with ICDS and APDU g) supporting development of EICDs with Radiometer h) supporting development of ICDs with Thermal and Mechanical i) providing a detailed scatterometer design j) developing a scat. test plan k) developing the scat. test procedures l) overseeing parts reliability issues m) delivering an HRCR and EIDP n) overseeing subcontract technical management o) providing subcontract technical specifications 2) Detailed Design effort a) development of level 5 requirements b) developing detailed mechanical de analysis d) design and fabrication of Bench Checkout Equipment (BCE) 3) Parts Ordering 4) Chirp Generator Fabrication and Assembly a) complete BB/EM of chirp generator fabrication 5) Chirp Gen./SBE/SFE BB/EM I&T a) integrate CG w/SBE b) test integrated CG/SBE c) suppport interface verification tests with ICDS/APDU 6) FM Subassembly Testing and Design Revisions a) implement design changes for FM b) deliver schematics, parts lists, and assy procedures c) deliver reliability analyses reports 7) FM Chirp Gen. Fab. And Assy. a) fabricate and assemble FM chirp generate b) integrate chirp gen. with SBE 8) FM CG/SBE/SFE I&T a) bench test all subassemblies b) thermal test FM subassemblies c) generate test reports 9) FM Subassy. I&T a) integration of subassembly units b) generate test report c) support interface verification tests d) perform post environmental test check-out e) develop operations related documents f) prepare HRCR documentation
05.06.02	Scatterometer Packaging	James Bowen	Provides for packaging design for the scatterometer subsystem. There are two principal efforts: 1) Packaging design for the Chirp Generator and, 2) Development and maintainence of MICDs for the scatterometer subsystem.
05.06.03	Scatterometer BCE & Test	James Bowen	Provides for packaging design for the scatterometer subsystem. There are two principal efforts: 1) Packaging design for the Chirp Generator and, 2) Development and maintainence of MICDs for the scatterometer subsystem.
05.06.04	Scatterometer SSPA Dev	Liou Ronglin	SSPA Dev: Fabricate an RF deck brassboard and test it as an EM. The RF brassboard will be integrated with the low voltage power supplier breadboard (as an SSPA breadboard) and delivered to scatterometer in April, 06 timeframe to assist subsystem functional testing. Reliability analysis includes thermal analysis flowing into worst case circuit analysis (DC circuits), mechanical analysis, parts stress analysis, and interface FMECA. Test procedures, interface control drawings and parts list will be provided. A CDR will be conducted prior to the PFM build (approximately 9 month after the PDR.) Design, develop, fabricate and test one PFM L-Band 200W Pulsed Solid State Power Amplifier RF deck and be delivered to SSPA Integration and Test. SWA PS: Complete part of Phase B effort, Complete the Bread testing and packaging concept and improve efficiency. Update Power Supply Requirement document and release, Update design to accomadate Input Bus Change Update Schematics and Parts List, Electrical Stress Analysis in adequate detail to support Thermal design. Generate specification for Inductors and Transformer and procure inductors and transformers to the specifications Order flight pats (Minimum of Jantxv, Level II). Complete packaging and detail design and conduct necessary Analysis (Structural and Thermal). Measure loop phase/gain of completed E SWA I&T: Low voltage power supplier and RF deck will be integrated to form a complete SSPA, fully tested, performance verified, and delivered to the Aquarius Scatterometer Instrument. End item data package will be compiled and provided.

Element Number	Element Name	Element Manager	Element Description
05.06.05	Scatterometer Front-End (SPE) Dev	James Bowen	Responsible to design, develop, fabricate, test and deliver the scatterometer front end (SFE). This effort will be performed as a subcontract, with management of the subcontract being performed by the Scatterometer Engineering cost account (102394/AQCDXX 05.06.01). The SFE is a switching assembly which routes the transmitted pulse from the SSPA to the selected feed/polarization. The SFE also routes the return echo from the selected feed/polarization to the receiver. Within the SFE, a portion of the transmitted signal is routed to the receiver as a loopback.
05.06.06	Sactterometer Back-End (SBE) Dev	James Bowen	Responsible to design, develop, fabricate, test and deliver the scatterometer back end (SBE). This effort will be performed as a subcontract, with management of the subcontract being performed by the Scatterometer Engineering cost account (102394/AQCDXX 05.06.01).
05.07	Radiometer	Fernando Pellerano	WBS Roll-up
05.07.01	Radiometer Management	Fernando Pellerano	Provide instrument management for radiometer team. This will include instrument management, resources analyst support, scheduling, and configuration support to the radiometer. The instrument manager and resources analyst will also serve as the main point of contact for all of the GSFC Aquarius elements.
05.07.02	Radiometer System Engineering	Fernando Pellerano	Provide instrument system engineering and electrical system engineering support for the radiometer instrument subsystem. Provide technical leadership to the team; establish technical requirements; establish technical interface requirements with JPL. Procure diplexer; provide harness to the radiometer subsystem. Support CDR, pre-environmental review, pre-ship review.
05.07.03	Radiometer Front-End Elec.	Fernando Pellerano	Design, develop, and test RF radiometer boxes which include 3 RF Front-end boxes, 1 RF Back-end box, and 3 correlated noise diode boxes. Testing will be functional test at box level in ambient environment. Support CDR, pre-environmental review, pre-ship review.
05.07.04	Radiometer AEU	Fernando Pellerano	Design, develop, and test the DPU. Testing the DPU will be at functional box level in ambient environment. Finalize the DPU/ICDS Interface Control Document. Support CDR, pre-environmental review, pre-ship review.
05.07.05	Radiometer I&T	Fernando Pellerano	Develop I&T plan, I&T test script, for the radiometer subsystem test. Manage the radiometer subsystem test, including environmental test, for the engineering units and the flight units. Support CDR, pre-environmental review, pre-ship review.
05.07.06	Radiometer Post-Delivery Support	Fernando Pellerano	Provide radiometer engineering support to the I&T effort at JPL and at Argentinia/Brazil. Provide launch support and early orbit checkout of the radiometer.
05.07.07	Radiometer Calibration-Validation	Fernando Pellerano	Provide pre-launch calibration support for the instrument development team and serve as interface between engineering and science teams on issues related to instrument calibration. Develop final pre-launch calibration plan. Design and develop necessary external calibration references and other ground support equipment. Support subsystem in defining and conducting performance test and assimilate data from the tests in support of pre-launch calibration. Conduct necessary measurements in support of pre-launch calibration activities. Support observatory I&T through launch. Provide the science team with state-zero calibration for the instrument. Document results in a final report.
05.07.08	Radiometer Mission Assurance	Fernando Pellerano	Safety and Mission Assurance Management is responsible for planning, organizing, directing, coordinating, and controlling all the the S&MA activities for the Aquarius Radiometer. These activities include Quality Engineering, Safety, Reliability, Parts Engineering, Materials Engineering, and Mission Operations Assurance. Review Test Plans/Procedures to ensure that JPL Environmental Requirements and GSFC GEVS requirements have been adequatley addressed.
05.08	Integration and Test	Charles Wu	WBS Roll-up
05.08.01	Instrument I&T	Charles Wu	WBS Roll-up
05.08.01.01	Instrument I&T Engineering	Charles Wu	Develop schedule and plan to integrate and functionally test the Instrument assemblies. Define Ground Support Test Equipment (GSE) and environmental tests at the Instrument level. Review instrument requirements and interface design. Review Subsystem Development and support the Subsystem EM/BB I&T Interface testing. Review instrument receivable and delivery items. Conduct Integration and Test of Flight Instrument and delivery of Instrument after all requirements and specifications are verified.
05.08.01.02	Instrument Environmental Testing	Charles Wu	To support facility and labor cost associated with the environmental testing of the Aquarius Instrument. The activities costed in this work unit include test conductors labor and facility test equipment, consumable material, etc.
05.08.01.03	Schedule Margin Instrument I&T and ATLO	Charles Wu	Costed schedule margin for Instrument I&T and ATLO

Element Number	Element Name	Element Manager	Element Description
05.08.01.04	ATLO Support at CONAE & Launch Site	Charles Wu	Support ATLO phase of Aquarius I&T for integration and test of the instrument with the spacecraft; to conduct Acceptance Test of the instrument after shipping, to conduct electrical and mechanical integration to the spacecraft, and to support environmental testing and pre-launch testing.
05.08.01.05	Electrical Ground Support Equipment Dev	Charles Wu	The Aquarius EGSE will be designed, built, tested and delivered under this work package. The EGSE will consist of both commercial and custom hardware and software which will operate the instrument by simulating the ground, and spacecraft platform. Functional and performance verification will be performed with instrumentation used to measure the radar output and inputs as well as the radiometer inputs. The EGSE will include the following major functions: Command & Data Interface Flight Power Interface Active and Passive Data Interface RF Test Set Manual and Scripted control of the EGSE Components and Flight Hardware Please see the attached Document "Aquarius EGSE MDD" for more details. This Document is attached under the resources area of this form.
06.0	Ground System	Gene Feldman	The complex of equipment, hardware, software, and facilities required to assemble, integrate, test, and operate the GDS. Includes the computers, communications, operating systems, and networking equipment needed to interconnect and host the MOS Software. CONAE is providing ground operations. NASA ground system development is limited to development of instrument commands for the radiometer and radar and the science operations center.
06.01	Ground System Coordination	Gene Feldman	Complete interface definition and prepare final ICDs; test and verify all interfaces; complete science data product specifications; develop detailed ADPS design, prepare for and present at NASA-focus CDR; develop the Level 0-to-1A software; package the science (Level 1B, 2 and 3) processing software; integrate and test all software with the data processing system; develop methodologies, tools, procedures and reports for operational QC and validation; develop interface with the Aquarius Validation Data System (AVDS); implement browse, search and order capability; verify processing, storage and network capability; participation in data flows and mission simulations; prepare data processing plan; participate in pre-launch readiness reviews.
06.02	Aquarius Command and Control System (ACCS)	Gene Feldman	Complete interface definition and prepare final ICDs; test and verify all interfaces; develop detailed ACCS design, prepare for and present at CONAE-focus CDR; develop the command scheduling software; implement and populate the instrument command database; develop command scripts for routine operations, instrument configuration and checkout and contingency operations; integrate and test the command database and scheduling software; develop the operations plan; support early orbit and instrument checkout planning; participation in mission simulations; participate in pre-launch readiness reviews.
06.05	PO.DAAC	Kelley Case	WBS Roll-up
06.05.01	Task Management	Kelley Case	PO.DAAC will provide data ingest, archiving and distribution services to the Aquarius mission. During the Implementation Phase, the PO.DAAC will participate with the Aquarius Data Processing Segment (ADPS) in mission review meetings as required, and support Aquarius Ground System coordination planning activities.
06.05.02	System Engineering	Kelley Case	The PO.DAAC will provide data ingest, archiving and distribution services to the Aquarius mission. During the Implementation Phase, PO.DAAC will be responsible to write the Interface Control Document (ICD) between the PO.DAAC and the Aquarius Data Processing Segment (ADPS). PO.DAAC will participate with the ground system development team to help define and understand the metadata and the data formats. The PO.DAAC will provide a final version of the Interface Control Document (ICD)between the PO.DAAC and the Aquarius Data Processing Segment (ADPS).
06.05.03	System Modification & Testing	Kelley Case	The PO.DAAC willl provide data ingest, archiving and distribution services to the Aquarius mission. During the Implementation Phase, the PO.DAAC will write ingest scripts and data loaders for the PO.DAAC ingest system, and provide support for testing the interface between the ADPS and PO.DAAC systems. The PO.DAAC will support end-to-end testing of the Aquarius Data Processing Segment prior to the Operational Readiness Review.
07.0	Operations	Scott Greatorex	The complex of human resources, services, and facilities required to assemble, integrate, train, and test personnel to operate the ground system and Spacecraft according to the Mission plan.

Element Number	Element Name	Element Manager	Element Description
07.01	Management	Scott Greatorex	WBS Roll-up
07.01.01	GSFC Ops Management	Scott Greatorex	Project Management is solely responsible for the business and administrative planning, organizing, directing, coordinating, controlling.
07.02	Science & Data Analysis	Gary Lagerloef	WBS Roll-up
07.02.01	ESR & PI Science	Gary Lagerloef	Provide (1) PI Management, support and research, (2) AVDS & Aquarius data calibration/validation and (3) Post-Launch scientific research and analysis for Aquarius Operations Phase.
07.02.02	GSFC, DPI and External Cal Science	David LeVine	Provide science management support by the Deputy PI and science application and evaluation of Aquarius data
07.02.03	JPL Co-I and PS Science	Yi Chao	Provide the science support to the Aquarius Project, data analysis and research, JPL Point of Contact for Aquarius, resource analysis support.
07.02.04	JPL Ops Business Management	Amit Sen	Funds business and resource control activities for the Project. Includes business planning, financial control, production of cost estimates, and operation of reporting systems.
07.03	Ground System Operations	Gene Feldman	WBS Roll-up
07.03.01	ACCS	Gene Feldman	
07.03.02	ADPS	Gene Feldman	
07.03.03	PO-DAAC	Kelley Case	WBS Roll-up
07.03.03.01	JPL GS Management	Kelley Case	PO.DAAC will provide data ingest, archiving and distribution services to the Aquarius mission. During the Operational Phase, PO.DAAC will report metrics for ingest and distribution activities, participate in mission review meetings and Science Working Team meetings as required, and support Aquarius Ground System activities.
07.03.03.02	JPL Data Engineering	Kelley Case	The PO.DAAC will provide data ingest, archiving and distribution services to the Aquarius mission. The PO.DAAC will provide read software and adequate documentation of the Aquarius salinity data products to permit the use of these products by the scientific community. PO.DAAC will provide data support to the general scientific community. The PO.DAAC will submit Aquarius metadata to NASA Earth Science search catalogs, e.g., Global Change Master Directory.
07.03.03.03	JPL Operations	Kelley Case	The PO.DAAC will provide data ingest, archiving and distribution services to the Aquarius mission. During the operational period, the PO.DAAC will assign a part-time operator and a part-time User Services staff member to the Aquarius mission to insure the smooth flow of the data into the archive, and to provide access to the data by the general public. The PO.DAAC will assign a part-time Sustaining Engineer to support the Project as needed for the maintenance of the archive and of the system which supports the archive.
07.04	Calibration & Validation	David LeVine	WBS Roll-up
07.04.01	Radiometer Calibration & Inst Support	David LeVine	Provide engineering support for the radiometer during commissioning and afterward to support calibration and validation of performance.
07.04.02	Scatterometer Calibration & Sustaining Engineering Support	Simon Yueh	WBS Roll-up
07.04.02.01	Scatterometer Calibration & Inst Support	Simon Yueh	Perform the postlaunch radar calibration and validation; Health and safety checkout, including functionality, anomaly detection and initial processor verification; Develop and update radar retrieval software for Tb correction; Deliver radar retrieval calibration curves for Tb calibration to Ground System; Update calibration and retrieval algorithm and table.
07.04.02.02	Instrument Sustaining Engineering Support	Amit Sen	Provide Instrument Sustaining Engineering Support during Operations
07.04.02.03	Instrument Testbed Support	Amit Sen	Provide Instrument testbed support during operations
07.04.02.04	Observatory Insight Sustaining Engineering Support	Amit Sen	Provide Observatory Insight sustaining support during operations
07.04.03	Algorithm Validation and Tuning	David LeVine	Research to provide calibration and validation of the Aquarius data product and refinement of retrieval and cal/val algorithms.
07.04.04	Drifters	Gary Lagerloef	No Activity

Element Number	Element Name	Element Manager	Element Description
07.05	Education	Annette DeCharon	WBS Roll-up
07.05.01	Task Management	Annette DeCharon	The Aquarius EPO goal is to stimulate public interest in and understanding of Earth system science and encourage young scholars to consider careers in science and technology. The primary educational goal is to demonstrate how better understanding of salinity-driven circulation -- and its effect on climate and the water cycle -- can benefit student learning and society as whole. Task Management includes promoting and overseeing collaboration among the EPO team, including several US partners (e.g., Ocean Institute, Duke University, McREL, etc.) and the SAC-D Education Lead. Task management also includes reporting to weekly, monthly, and quarterly Project progress reviews. Deliverables will include all necessary contributions to Project level documentation.
07.05.02	Informal Education	Annette DeCharon	WBS Roll-up
07.05.02.01	SSS Website	Annette DeCharon	Aquarius informal education activities are designed to increase public awareness and understanding of how the Earth functions as a system and NASA's role in enabling development of that knowledge. The EPO Lead is responsible for overall coordination of Aquarius team members, informal education partners, and the technical implementation team. In addition, as part of the informal education effort, the Aquarius EPO Lead will present results at professional conferences each year.
07.05.02.05	Interactive Salinity Modeling Tool Integration	Yi Chao	To support the Aquarius Education and Public Outreach manager to develop the salinity data and models front end.
07.05.02.06	JPL Salinity Data & Models Front-End	Yi Chao	To support the Aquarius Education and Public Outreach manager to develop the salinity data and models front end.
07.05.03	Formal Education	Annette DeCharon	WBS Roll-up
07.05.03.02	Time Series Analysis	Annette DeCharon	Aquarius formal education activities will enable the use of Earth science information and results in teaching and learning at several levels of education. Aquarius professional development activities will build capacity for productive use of Earth science results, technology, and information in resolving everyday practical problems. Aquarius EPO will: Develop leading- edge techniques utilizing various media technology to foster student interaction with data and information; Collaborate with other education efforts that connect and complement the Aquarius core theme areas (i.e., water cycle, ocean circulation and climate); and Demonstrate NASA's commitment to providing high-quality educational material to traditionally underrepresented audiences by promoting the participation of the under-served and underrepresented segments of the population as characterized by demographic, social-cultural, and economic variables.
07.05.03.03	JPL Interactive Salinity Modeling tool Dev	Yi Chao	To develop an interactive salinity tool using the salinity modeling tool developed during the phase C/D in support of the Aquarius education and public outreach activities.
07.05.03.04	JPL Interactive Salinity Database	Yi Chao	To develop an interactive salinity tool using the salinity modeling tool developed during the phase C/D in support of the Aquarius education and public outreach activities.
07.05.04	Education Evaluation	Yi Chao	WBS Roll-up
07.05.04.03	Education Evaluation	Yi Chao	To complete the development of the interactive salinity database initiated during the phase C/D.
08.0	Pre-Launch Education	Annette DeCharon	AQUARIUS EP/O WILL RELY ON THE COLLABORATON BETWEEN THE EXTENDED OUTREACH TEAM AND INSTRUCTIONAL MATERIAL EXPERTS. EACH CENTER WILL CONDUCT SPECIFIC ACTIVITIES THAT WILL BE LEVERAGED BY ALL PARTNERS. BIGELOW LABORATORY will lead these activities, among others: Coordination overall EP/O effort; "Salinity Patterns & the Water Cycle" module; "Salinity & Climate" module; Aquarius Launch Fact Sheets; Interactive salinity modeling tools Under subcontract from Bigelow Laboratory, Mid-Continent Research for Education and Learning (McREL) will evaluate products and the overall program Under subcontract from Bigelow Laboratory, Duke University will develop and test salinity times-series data-related activities for undergraduate and high school audiences

Element Number	Element Name	Element Manager	Element Description
08.01	Task Management	Annette DeCharon	WBS Roll-up
08.01.01	Task Management	Annette DeCharon	The EPO Task Manager, located at Bigelow Laboratory, will oversee activities and facilitate coordination among the Aquarius team and its education partners. A detailed schedule of WBS 8 deliverables, receivables, and milestones of the Aquarius Mission is maintained by the EPO Task Manager. EPO reporting consists of weekly (e.g., Level 2 Managers telecons), monthly (e.g., Monthly Management Reviews), and other progress reviews (e.g., Preliminary Design Review).
08.02	Informal Education	Annette DeCharon	WBS Roll-up
08.02.01	Sea Surface Salinity Website	Annette DeCharon	In addition to the wealth of education-related material that will be available on the Aquarius public website, we are committed to bringing Aquarius data and mission findings to the general public in a highly visible and engaging way. We will also publish "Launch Anniversary" updates with synopses of the instrument performance, volume and status of data collected, science findings, and educational product releases from the previous year.
08.02.02	"Mission Overview" Module	Annette DeCharon	Module about the pioneering mission to map global salinity. Content focuses on the following: 1) Salinity has never been measured over 24% of the ocean; and 2) Salinity can affect weather and climate over land areas.
08.02.03	"Salinity & Climate" Module	Annette DeCharon	Module will augment existing El Niño / La Niña materials with salinity-based content. Will focus on the following: 1) Aquarius data will improve climate forecasting; and 2) El Niño and La Niña are influenced by ocean salinity.
08.02.04	"Aquarius/SAC-D Fact Sheet"	Annette DeCharon	To be published just prior to the Aquarius launch, these easily duplicated documents will have basic information about the overall mission and conform to relevant NASA formatting standards.
08.02.05	Interactive Salinity Modeling Tool Integration	Annette DeCharon	Integration of on-line interactive salinity data exploration tools and models for public audiences. Tool will show how environmental changes affect air-sea interchange and climate by allowing interactive exploration of various data sets, with a focus on salinity.
08.02.06	Salinity Data & Models Front End	Yi Chao	On-line interactive tools will show how changes in salinity affect air-sea interchange and climate by allowing interactive exploration of various data sets and models, with a focus on salinity. Summer interns at Caltech, under the guidance of Aquarius Project Scientist Dr. Yi Chao, will conduct much of the work. The Aquarius EPO Lead will be responsible for ensuring that the resulting interfaces are "user friendly."
08.03	Formal Education	Annette DeCharon	WBS Roll-up
08.03.01	Pre-College Activities & Content Development	Annette DeCharon	Includes development of "hands on" and other activities to be conducted by students and / or educators to understand salt-water interactions. Content focuses on the concept that salinity is vital to tracking interactions among the ocean, climate, and the hydrologic cycle.
08.03.02	"Time Series Analysis" Module	Annette DeCharon	Module will include in situ time-series salinity data for use in undergraduate and high school classrooms. Undergraduates at Duke University, under the guidance of Dr. Susan Lozier, will conduct much of the work.
08.03.03	Interactive Salinity Mideling Took Development	Yi Chao	On-line interactive tools will show how changes in salinity affect air-sea interchange and climate by allowing interactive exploration of various data sets and models, with a focus on salinity. Summer interns at Caltech, under the guidance of Aquarius Project Scientist Dr. Yi Chao, will conduct much of the work. The Aquarius EPO Lead will be responsible for ensuring that the resulting interfaces are "user friendly."
08.03.04	Interactive Salinity Database	Yi Chao	On-line interactive tools will show how changes in salinity affect air-sea interchange and climate by allowing interactive exploration of various data sets and models, with a focus on salinity. Summer interns at Caltech, under the guidance of Aquarius Project Scientist Dr. Yi Chao, will conduct much of the work. The Aquarius EPO Lead will be responsible for ensuring that the resulting interfaces are "user friendly."
08.04	Professional Development	Annette DeCharon	WBS Roll-up
08.04.01	Formative Evaluation	Annette DeCharon	We will coordinate the use of Aquarius formal education materials among educators for review, field-testing, and further content development, when necessary. McREL will conduct a written review for each module using a panel of six high school science and mathematics teachers recruited from schools in the Denver area. The same group of teachers will later be convened as a focus group to further investigate and clarify issues raised during the written review and to collect additional feedback and recommendations for improvement of the materials.

Element Number	Element Name	Element Manager	Element Description
08.04.02	Conference Support	Annette DeCharon	We will support science teachers to present Aquarius educational resources at professional society meetings (e.g., National Science Teacher Association, American Meteorological Society, National Marine Educators Association).
08.04.03	Program Summative Evaluation	Annette DeCharon	We will examine the effects or outcomes of the Aquarius Education program to determine its overall impact. Summative evaluation of the Aquarius education program will be conducted by McREL in partnership with NASA SMD-ES Education. A final written summative evaluation of the Aquarius EPO program will be provided as input for the Mission Post Launch Report prepared by JPL. The EPO input will be derived from the Aquarius evaluation team after a formal review process.
08.05	Launch Activities	Yi Chao	WBS Roll-up
08.05.01	Launch Exhibit	Yi Chao	Launch-related educational activities will educate and inform the public to the technical and scientific aspects of the Aquarius observatory and mission. EPO will work with the NASA entities to develop a public exhibit in conjunction with the Aquarius launch campaign. We will ensure that the Aquarius exhibit can be used in multiple venues. We will also make the art files available on line for museums to download and print themselves.
09.0	Launch System	Amit Sen	The primary means for providing initial thrust to place the flight system directly into its operational environment or on a trajectory towards its intended target. Includes Delta 7320-10 Launch Vehicle and associated Launch Services
10.0	Mission Assurance	Perry Danesh	The technical and management efforts of directing and controlling the mission assurance elements of the project. Includes design, development, review and verification of practices and procedures intended to assure that the delivered flight system and instruments/payloads meet performance requirements and function for their intended lifetimes. Excludes mission and product assurance efforts at partners/subcontractors other than a review/oversight function, and the direct cost of environmental testing.
10.01	Mission Assurance Manager	Perry Danesh	WBS Roll-up
10.01.01	JPL Management	Perry Danesh	This cost account provides for: (a) the management of the Mission Assurance for Aquarius Instrument, and (b) MAM"s support of Aquarius SAC-D technical interchange meetings. The mission assurance disciplines managed by the Mission Assurance Manager (MAM) are: (1) environmental requirement engineering, (2) EEE parts, (3) hardware quality assurance, (4) software quality assurance, (5) reliability engineering and (6) system safety. The MAM is the focal point for the project to the JPL Office of Safety and Mission Sucess(OSMS). As a part of this, the MAM manages the personnel and deliverables in the SMA disciplines, and manages the processes by which the SMA team does work. MAM leads an indepnedent team that assess the risks and reports to both the project office and JPL office of safety and mission sucess. "Scope of MAM"s work does NOT include providing insight into the S&MA related activities at the spacecraft provider, CONAE (except whatever insight the MAM receives during routine interfaces with CONAE S&MA through MMRs, TIMS, etc). There is very little independent insight planned by the MAM or other 5X disciplines for the spacecraft, therefore spacecraft risks be exposed via the MAM"s efforts"
10.02	System Safety	Cami Vongsouthy	WBS Roll-up
10.02.01	JPL System Safety	Cami Vongsouthy	Provide Systems Safety support for the Aquarius Project durng Phase C/D. Systems Safety generates System Safety plan, review safety requirements to ensure that appropriate safety requirements are flown down to Aquarius/Spacecraft. Systems Safety performs hazard analysis and generate Aquarius Safety Compliance Data Packages (SCDPs); Review/approve CONAE generated Observatory Missile System Pre-launch Safety Packages (MSPSPs) for submittal to KSC/Range Safety; coordinates safety milestones and deliverables with Aquarius Project and CONAE, conduct Systems Safety surveys (facility, operation, transportation) at JPL and at CONAE and Brazil (one in CONAE and one in Brazil) and Launch site; participate at major reviews (CDR, H/W Requirements Certification Reviews, Pre-ship reviews), review PFR, waivers/exceptions for safety impact; provide required support to Ground Operations Working Group (GOWG), Payload Safety Working Group. Provide periodic support during launch campaign.

Element Number	Element Name	Element Manager	Element Description
10.03	Instrument PA Support- - JPL	Perry Danesh	WBS Roll-up
10.03.01	Instrument EEE Parts	Thomas Brown	WBS Roll-up
10.03.01.01	Instrument EEE Parts	Thomas Brown	Phase C/D Parts Management support to Aquarius . 1. EEE PARTS ENGINEERING Coordinate EEE Parts program: covers MMRs, Mtgs, replans, project and peer reviews. Develop and document JPL parts requirements with department approval Review subcontractor (2) parts implementation plans Formal review of JPL and Subcontractor "As Designed" Parts Lists Review NSPARS and WAIVERS (limited qty) Failure Analysis - (limited qty) PL review limited to a one time review of a mature "as designed" PL. GIDEP alert tracking 2. EEE PARTS DESIGN SUPPORT Support CogE early part selection support for critical parts. Support Parts Issues/Resolution RADIATION TESTING (limited qty). TRAVEL IS NOT INCLUDED - Project/Mission Assurance will fund any required travel 3. ACQUISITION Procurement of flight parts to a "RELEASED" BOM (PL), tracking to receiving,stores and kitting. CTM support for procurement (limited qty) Preparation of JPL procurement specs (limited qty) 4. UPSCREEN / QUALIFICATION Major upscreens (limited qty). By direction, this is a "level 2" parts requirement project. Selected upscreens on level 2 parts will be provided as required by the parts specialist.
10.03.02	Instrument Env.	Bruce Krohn	Provide the environmental engineering function (ERE) and environmental specialist support to the Aquarius Project: 1. Provide inputs to the Aquarius/SAC-D Environmental Requirements Document and update as necessary. 2. Maintain Aquarius Test & Analysis Matrix. 3. Provide input and participate in project reviews (CDR, HR/CR). 4. Inputs to MMRs and selected peer reviews. 5. Aquarius lead environmental requirements engineer to coordinate environmental activities with SAC-D environmental requiements engineer. 6. Aquarius lead EMI/EMC engineer to coordinate system level electromagnetic compatibility with SAC-D Observatory. 7. Funding to EMC specialist to provide guidance in resolving EMC issues pertaining to design (Aquarius only). 8. Provide support for special studies related to environments and test strategies. 9. Responsible for the ETAS process related only to Aquarius testing activities. 10. Assist in closure of PFRs (funding up to 10 PFRs, not inclusive of a red-flag ERE held PFR). Fund specialist on issues related to failures and PFR closure. 11. Assist in the waiver/ECR process, if necessary. Funding budgeted for 5. 12. Limited monitoring of test activities (Surveys, TRR, test observing). Test activities to include dynamics, acoustics, thermal and EMC. Re-test rate used in estimate is 10%. 13. Support staff meetings, unanticpated effort, and other miscellaneous tasks. Not included in budget: 1. Foreign Travel costs. 2. Domestic travel costs. 3. Funding of all environmental tests (Dynamics, Acoustics, Thermal, and EMC/Magnetics). 4. Test activity supporting for non-flight hardware. 5. Test activity related to failure investigation. 6. Update to radiation model. 7. Radiation transport analysis. 8. "Watch dog" Aquarius environmental test activity after delivery to SAC-D. 9. Funding of EMC specialist related to providing design guidance to SAC-D. 10. ERE supported red-flag PFR.
10.03.03	Instrument QA	Richard Miseroy	WBS Roll-up
10.03.03.01	Instrument QA	Richard Miseroy	The Hardware Quality Assurance Engineer (HQAE) implements and flows down project quality requirements as defined in the Safety Mission Assurance Plan (SMAP), reviews project documentation and supports project meetings. The HQAE provides for an accurate measurement of the overall quality of a product during simulation of an end item''s use and function. This effort includes reviewing written test events and interfacing with project personnel during all levels of testing. In addition, the HQAE serves as the focal point for assuring the accurate recording of test data, test discrepancies, validation/certification of test hardware, and inputing of quality data records. The HQAE also serves as the interface with vendors on all quality related issues. Specific functions performed by the HQAE at this time are: 1. Perform source inspection. 2. Review & approve hardware build documentation at JPL for completeness and accuracy. 3. Perform workmanship inspections. 4. Review hardware and documentation and record discrepancies on Inspection Reports (IRs). 5. Support Hardware Review and Certification Review (HRCR). 6. Monitor/witness all levels of testing. 7. Witness/verify all handling operations. Assur 1. I&T at JPL is 1 shift per day, 5 days a week for 6 months. 2. ATLO support in Argentina and follow-on testing at Brazil is estimated at 1 trip per month for 6 months. 3. ATLO support at VAFB is estimated at 2 trips per month for 3 months. 3. Bldg 103 & 170 inspection activities not included in this WA. 4. Estimate based upon no major rework or retest and no late deliveries. 5. GSFC will support all radiometer HQA. 6. Estimated number of supplier surveys is 5. Potential suppliers and capabilities not known, may have to perform more surveys than the estimated 5. 7. Estimated number of IRs is 500 (similar to GALEX). 8. Estimated number of AIDS is between 150-200 (similar to GALEX and MIRO). 9. Overseas travel is funded by the project office.
10.03.04	Instrument SWQA	Ronald Kandt	The work will assess the quality of the software development processes and the resulting software products. To this end, the assigned SQA Engineer will: - Participate in milestone and peer reviews - Perform process audits - Generate status reports

Element Number	Element Name	Element Manager	Element Description
10.03.05	Instrument Rel.	John Klohoker	WBS Roll-up
10.03.05.01	Instrument Rel.	John Klohoker	1. Support is limited to the JPL portion of the Aquarius Instrument. Reliability Engineering (5131) shall not provide support for the GSFC provided Radiometer. 2. Reliability Engineering shall operate in "review" mode. 3. Provide Concurrent Engineering/Design Support services with the Level of Effort not to exceed 40 hours per month. This task/effort shall include: a) Prepare Aquarius Reliability Plan b) Prepare P/FR Plan and set-up the PRS system for Aquarius use c) Participate in formal Project Reviews (i.e.,CDR, ARR, etc) d) Participate in informal Project Meetings (i.e., MA, Design Team, MMR, etc.) e) Participate in hardware reviews (i.e., HRCRs, etc.) f) Provide guidance and direction to cognizant personnel performing design verification analyses. Reliability shall not perform any design verification analyses. g) ECR/Waiver support h) Ad Hoc Tasks (i.e., cost exercises, replans, etc.) as directed by the MAM 4. Review Scatterometer Antenna Deployment Mechanism Fault Tree Analysis. 5. Review Instrument - Spacecraft Interface Failure Modes, Effects, & Criticality Analysis (FMECA) 6. Review APDU, ICDS, and Scatterometer Electronic Parts Stress Analyses (EPSAs) 7. Review APDU, ICD Worst-Case Circuit Analyses (WCCAs) 8. Review APDU, ICDS, and Scatterometer Single Event Effects Analyses (SEEAs) 9. Review GSE-Flight Hardware Interface FMECAs 10. Review/Close 100 Problem/Failure Reports (P/FRs) 11. There shall only be one review per analysis. Subsequent reviews, as the result of analysis changes due to findings in the original analysis, shall be funded through the MAM"s account or a project lien. 12. Travel is not included in this budget. Any Project Required travel shall be funded through the MAM"s account or a project lien. 13. Probabilisitic Risk Assessment (PRA) support is not included in this budget. Any Project Required PRA support shall be funded through the MAM"s account or a project lien.